POWER

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Power and the World's Work

THE hope that springs eternal in the breast of every thinker, every wisher for human progress, is for the time when every member of the human family can contribute that which he is best able to perform to the common task, and for that contribution receive a goodly share of the comforts and enjoyments of life, immunity from want and deprivation, and the opportunity to cultivate such tastes and talent as he may have been endowed with to the end that he may still better serve.

In an address at the University of Virginia, Dean Kimball, president of the American Society of Mechanical Engineers, made the assertion that by reason of the progress that we have made in the arts and sciences, by reason of the organization of industry, of mass production, of our growing knowledge how best to use the materials and forces of nature and the growing capabilities of man himself, we are nearer to that possibility than we have ever been before in the history of the race.

The scale upon which the race can live depends upon the amount of work that the race can do.

If we would eat, we must produce and prepare and preserve and distribute food.

A knowledge of scientific agriculture, the intelligent suppression of insect and other enemies to crops, the cultivation of new and the improvement of old food crops and cattle, agricultural machinery, the improvement in processes of preparation and systems of distribution have made the problem of feeding the race vastly easier.

The work necessary to maintain the race upon a given scale has been greatly reduced by the development of power. Without the heat engine and the power from falling water mankind would have a much harder struggle against its environment. Without power-driven machinery how many of the conveniences and comforts that we now enjoy would be impossible.

Every labor-saving device, every improvement in efficiency, every avoidance of waste, especially of labor, makes for a better living for all of us when we master the problem of distributing its advantages fairly.

Life is a continual struggle. "In the sweat of thy face shalt thou eat bread." The more bread we would eat, the more of the good things of life we would enjoy, the more we must work — for somebody has to make the goods or perform the service. The more efficiently the work is done the easier it will be for everybody, and power is the greatest factor in lightening the load.

F. R. Low

Welding Tubes into the Tube Sheets of Boilers*

By FRED H WILLIAMS
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BOILER PLATE, unless it is of the very best material, is often the cause of many troubles in the welding of the tubes into the sheet. The very method of making the plate tends to poor and non-uniform structure unless strict instructions are given as to the cropping, and are followed out. The

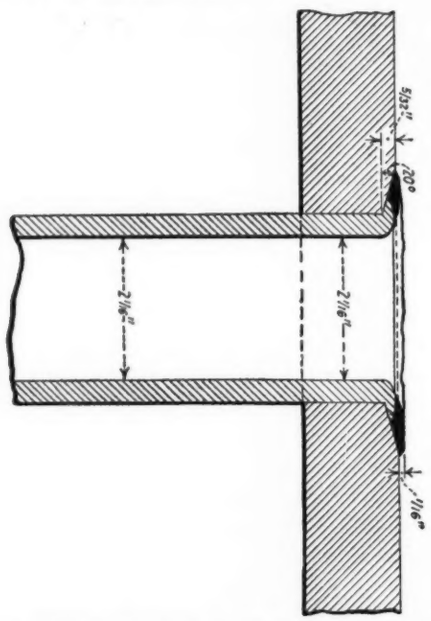


FIG. 1—SUCCESSFUL WELDING METHOD. FULL TUBE AREA AVAILABLE

impurities that go to the central part of the ingot will form flaws that will ultimately find their way into the weld and in time result in leaks and fractures.

The tube sheet is countersunk 5/32 in. deep at an angle of 20 deg. The tube is rolled in without copper ferrule and with its end flush with the face of the sheet; it is flanged over after the rolling and the rest of the countersink is filled in with the deposited metal in the welding operation, as illustrated in Fig. 1.

The only objection possible with this method is the fact that in time a space on the inner side of the sheet might open up and allow sediment to collect and thus reduce the heat-carrying capacity of the sheet. This might result in burning the tube just back of the sheet. It is possible that this would be overcome by rolling the tubes into the sheet tighter.

Two kinds of electrodes were used with usual style of welding, and three tubes were welded by each kind, with the result that five out of the six resisted the tensile stress required to pull the tube apart.

From the appearance of the welds and the results of the tensile tests, those made with the "Quasi Arc" electrodes gave every indication of being the best.

*While the results given are developed in locomotive practice, it is felt that the information will be valuable where special conditions favor welding of stationary boiler tubes. Excessive temperature of the crown sheet is the main reason for welding locomotive tubes at one end, the other being rolled.—EDITOR.

In determining the best method of welding the tubes into the tube sheet, the writer gave consideration to three things: (1) The effect of the welding on the metal of both the tube and the tube sheet; (2) the effect of the final outline of the tube end, the tube sheet and the deposited metal, upon the hot gases entering the tube; (3) the amount of work required to perform the entire operation from start to finish.

1. The effect of the weld, or rather the heat of the arc, on the metals to be welded involves a reconsideration of some of the points brought out in a previous part of the study. The tube itself does not require much attention other than that the end should be as nearly square as possible so that it will not be burnt by the heat of the arc, because of its comparative thinness relative to the sheet. The sheet requires more attention, owing to the ghost lines that occur in the inner portion of the steel plate. For example, a plate of ½-in. thickness, such as used for this work in general, is usually free from these lines for about ⅛ in. from each surface; the inner ¼ in. is often streaked with several of these lines. These ghost lines, under the heat of the arc, become segregated into dark or

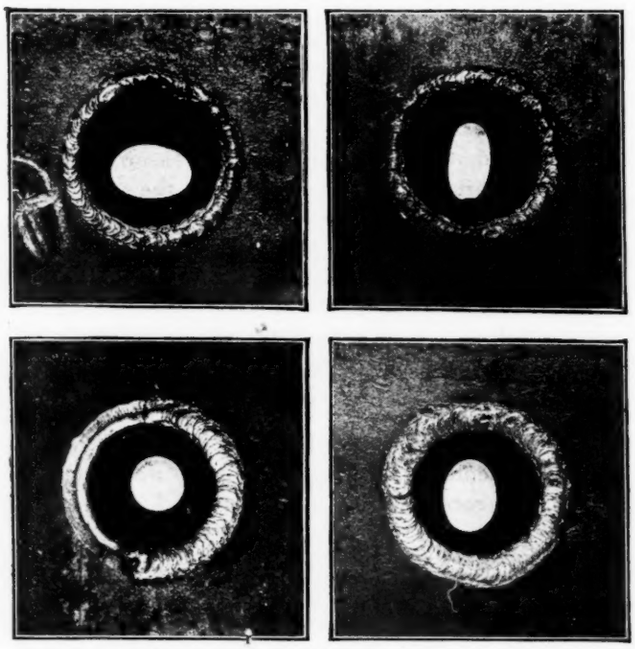


FIG. 2—USUAL WELDING (ABOVE) IS ROUGHER THAN THE QUASI ARC METHOD (BELOW)

dove-gray spots according to their composition, and in the case of the dark spots result in a brittle structure in the weld, both in the deposited metal and the plate itself, thus lowering the tensile strength of the whole weld. The design of the tube welding as presented by the writer is therefore better because the metal of the plate is melted only in that part of the plate that is of the best quality; namely, the outer ⅛ in. of the plate thickness.

2. The design of the completed weld is such that the sectional area of the tube is not decreased at the entrance as in the case of other methods. In fact the mouth is more or less enlarged; the weld is also flush with the surface of the tube sheet, leaving a clean

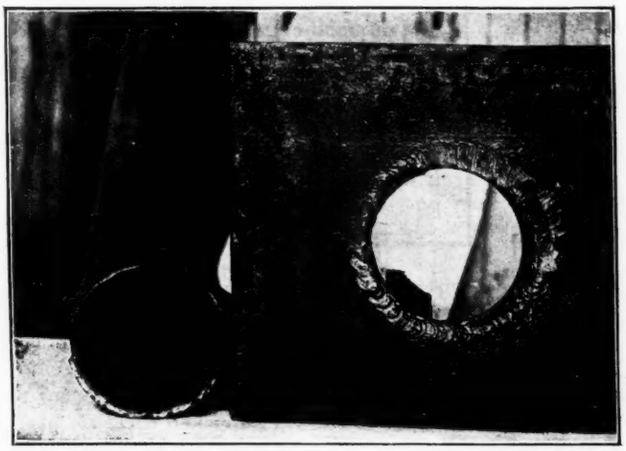
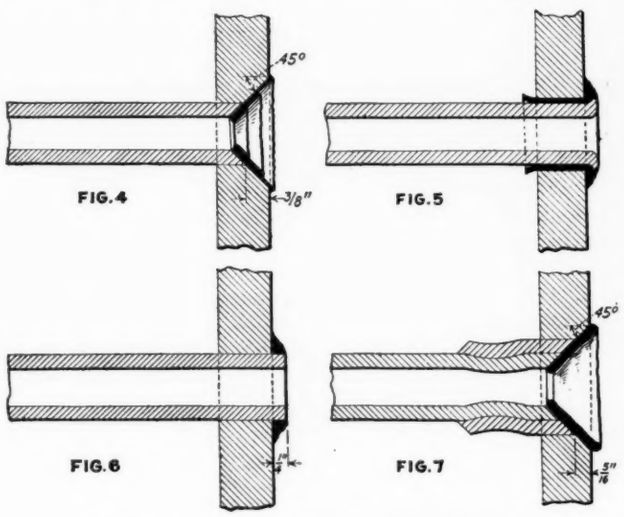


FIG. 3—EXCESSIVE ROLLING WEAKENED TUBE WITH QUASI ARC WELD

surface and entrance for the gases to flow unobstructed into the tubes.

3. The work of preparing the weld is very simple and quick. The tube sheet is drilled as usual and the hole chamfered $\frac{3}{32}$ in. deep, at an angle of 20 deg. The tube is inserted and rolled after it has been cut off flush with the sheet. The end is then turned over as shown in the sketch and welded with one bead around the edge of the tube.

See microphotographs, Fig. 8, included in this study for a fracture of a tube that had been welded according



FIGS. 4, 5, 6 AND 7—BAD JOINTS WITH BARE WIRE WELDING

Figs. 4 and 5. Broke weld in both pulling and pushing, while 12 per cent tube area is lost. Fig. 5 developed welding trouble from oil. Fig. 6 failed as a result of bead around tube end, contracting. Fig. 7 showed low tensile strength, weakened tube and area contraction of 38 per cent.

to a method that took the arc into the ghost line affected area of the plate. Note the thread-like lines of the fracture jumping from one dark spot to another, making an irregular break which would give a dark appearance upon examination with the naked eye. These spots are about $\frac{1}{3,200}$ in. in diameter and in themselves are not of much account, but the number makes the weld and the plate metal just as if it were perforated and thus causes the fracture to occur before it otherwise would.

The same design was tried by the quasi arc method of welding, in which an arc is drawn to begin melting of the specially cored wire. After this point is reached, melting is continued by a quasi arc, formed to the highly conducting core of the special wire, and the steel forming the bead is protected from oxidation by means of a slag-like covering on this wire, which melts and covers the weld.

Three tests of this welding showed stresses of 38,600, 38,700 and 39,400 lb. respectively, all tubes breaking six inches away from the tube sheets. An additional test with the usual method of welding showed fracturing stresses higher than the foregoing, indicating that the former method did not necessarily produce a stronger joint than the latter, although it is much smoother in appearance.

The tube, Fig. 4, was rolled and fastened with two or three beads. A copper ferrule was used in Fig. 5, pros-

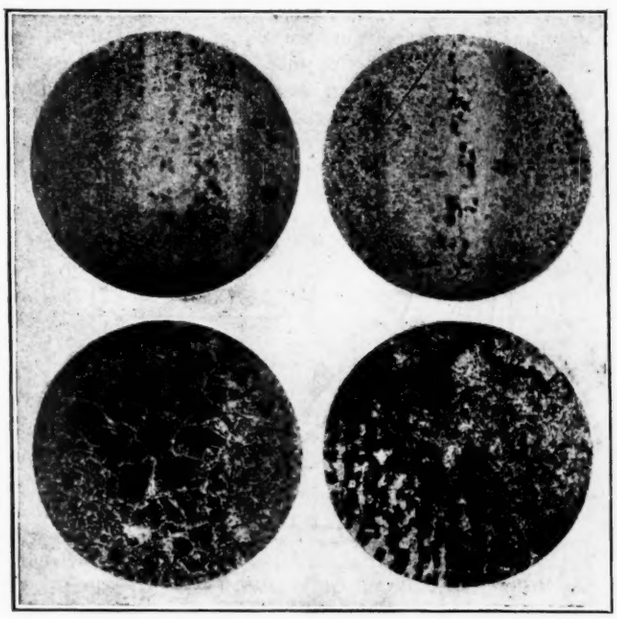


FIG. 8—IMPURITIES OF TUBE SHEET AFFECT WELDING

Lines in metal develop spots at the weld, shown above, produce coarse deposit of bead, resulting in fracture at spot under test. The spots are probably alloys of manganese, silicon, etc.

sered, rolled and headed. The tube in Fig. 6 was rolled with welded fillet. In Fig. 7, the ferrule is of steel welded on a swaged tube.

The proper amount of lead to give the steam valves of an engine may be assumed to be $\frac{1}{32}$ in. per foot of piston stroke. For example, a 36-in. stroke engine would call for a lead of $\frac{3}{32}$ in. The indicator should always be used in checking the valves after giving them lead. It is essential that the lead be such that the indicator diagram shows the compression line to merge with the admission line without abruptness. Usually, the correct lead is that value at which the engine runs without pound.

What Can We Expect from the Compound Gas Engine?

IN VIEW of the interest being taken in the compound internal-combustion engine, this discussion should prove of value. It is shown here that intercooling during compression in an internal-combustion engine will increase its thermal efficiency and will also increase the power developed by the engine by 50 per cent. However, as the author proves, the intercooling process is of little advantage unless it is the means of increasing the possible compression range.

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IT IS a well-known fact that the efficiency of a gas engine depends upon the compression ratio. However, owing to preignition and detonation difficulties, most internal-combustion engines operating on the Otto cycle are limited to a compression range of four to one. The cooling of the gas mixture during the compression period may be used to make possible a higher compression pressure by keeping the temperature below the preignition point. As a result it is possible to realize a higher thermal efficiency because of the greater expansion ratio following combustion of the charge.

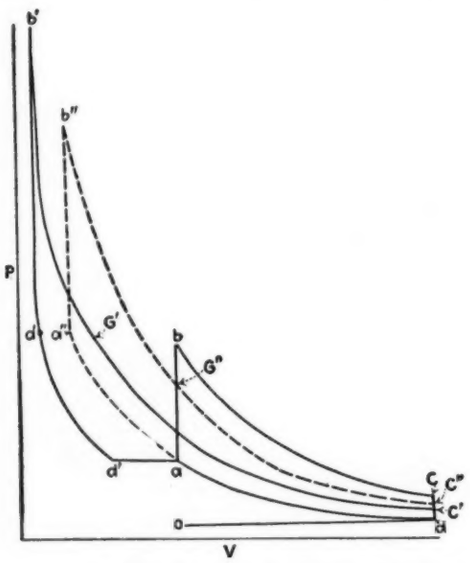


FIG. 1—DIAGRAMS OF COMPOUND AND OTTO-CYCLE ENGINES

No experimental data are available on engines operating with the intercooling process, although Ricardo and certain European engineers have worked on modifications of the process for the purpose of increasing the possible mean effective pressure in a given cylinder. It is, therefore, not possible to compare the relative performance of actual engines, but it is thought that a comparison of the relative performance on the air-standard basis will fairly well indicate the possibilities of relative performance of these engines. For this reason all following comparisons are made on this basis, the intercooling compression process is first applied to constant-volume cycles and secondly to constant-pressure cycles.

In Fig. 1, *dad'a'b'C'* represents a constant-volume compound intercooling cycle and *dabC* and *da''b''C''* respectively represent Otto single compression cycles in which the compression pressure is carried, first, to that in the low-pressure cylinder of the intercooling cycle and, secondly, to that existing in the high-pressure cylinder of the intercooling cycle. An inspection of the diagrams at once shows the very marked increase of the expansion ratio because of the intercooling process. The gain in efficiency due to this is partly offset by the heat rejected during the cooling process *ad'*.

Referring to Fig. 2, Curve *A* represents the thermal efficiency of the Otto cycle plotted against compression ratios equal to those represented on the upper scale for the low-pressure cylinder of the intercooling engine.

The curves *B*, *C*, *D*, *E* and *F* represent efficiency curves for the intercooling cycle for various maximum combustion temperatures. The compression pressures attained in the low- and the high-pressure cylinders under these conditions are shown by the scale at the bottom of the chart. The total expansion ratio is a graphical picture of the relative thermal efficiencies of the cycles shown in Fig. 1.

The curve *B* represents the variation of efficiency of that intercooling cycle in which the expansion is carried to the back pressure, whence $P_c = P_d$ in Fig. 1. The combustion temperature for each of the curves *C*, *D*, *E* and *F* is shown, and it is seen that each curve has a maximum point of efficiency and that each curve will cross the curve *B*. The point of intersection with *B* indicates in each case the compression ratio for this combustion temperature which results in complete expansion.

It is important to note that maximum efficiency is not obtained with complete expansion, and further that for Otto compression ratios below six the intercooling cycle has a decided thermal advantage, but for compression ratios over seven the Otto cycle has an advantage.

Further inspection of Fig. 2 shows that the combustion temperature has a greater effect on the engine efficiency for the higher compression ratios. This is an important consideration when determining the best method of governing the engine. It is apparent that to maintain a high efficiency at light loads for high compression ratios, the engine should be so governed as to maintain the combustion temperature nearly constant.

It will now be interesting to determine the probable effect on the engine weight by using the intercooling process within the range of conditions in which it possesses a thermal advantage.

The ratio of work obtained from the compressed intercooling and from the Otto-cycle engine is shown in Fig. 3 for different compression ratios and final temperatures. The ratio of work factors is seen to be

considerably greater than unity for normal combustion temperatures and compression ratios, which shows a thermal advantage for the intercooling cycle (that is, for compression ratios up to five). To arrive at some definite figures for a case in which the intercooling cycle appears to have an advantage, the following example will suffice:

If a fuel such as illuminating gas is considered, the normal practicable compression ratio in a single

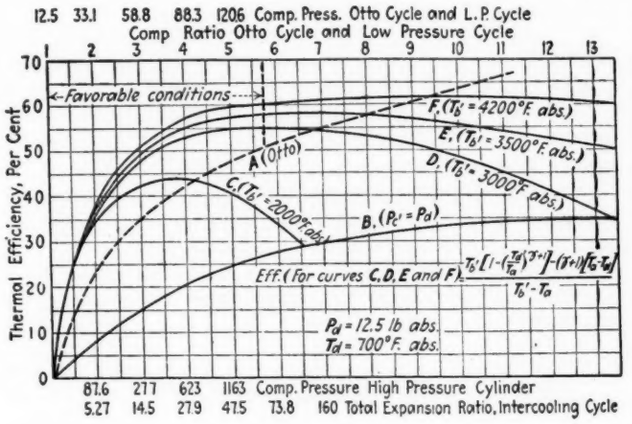

12.5 33.1 58.8 88.3 120.6 Comp. Press. Otto Cycle and L. P. Cycle
Comp. Ratio Otto Cycle and Low Pressure Cycle
Thermal Efficiency, Per Cent
<-Favorable conditions->
A (Otto)
F, (T_b' = 4200° F. abs.)
E, (T_b' = 3500° F. abs.)
D, (T_b' = 3000° F. abs.)
C, (T_b' = 2000° F. abs.)
B, (P_c' = P_d)
Eff. (For curves C, D, E and F) $\frac{T_b'\left[1-\left(\frac{T_d}{T_a}\right)^{\gamma-1}\right]-(\gamma-1)[T_a-T_d]}{T_b'-T_a}$
P_d = 12.5 lb abs.
T_d = 700° F. abs.
87.6 277 623 1163 Comp. Pressure High Pressure Cylinder
5.27 14.5 27.9 47.5 73.8 160 Total Expansion Ratio, Intercooling Cycle

FIG. 2—THERMAL EFFICIENCIES AT VARIOUS COMPRESSION RATIOS

cylinder is about four; for certain liquid fuels such as gasoline and kerosene the normal practical compression of the fuel mixture in a single cylinder is likewise about four. Such fuels may be used successfully in the intercooling engine in which the low-pressure cylinder has a compression ratio of four, but in this case the total expansion ratio will now be 28 instead of 4. By reference to Figs. 2 and 3 the following data may be obtained for a combustion temperature of 3,500 deg. F. absolute, and for a temperature of 700 deg. and a pressure of 12.5 lb. absolute at the beginning of compression.

	Intercooling Engine	Otto Engine
Compression ratio (l.p. cyl.)	4	4
Expansion ratio (total)	27.9	4
Thermal efficiency, per cent (air standard)	55	42.5
Compression pressure, lb. (l.p. cyl.)	88.3	88.3
(h.p. cyl.)	623	
Temperature after compression, deg. F. absolute	1,048	1,048
Maximum pressure, lb. per sq.in.	2,050	295
Ratio of work per cycle of intercooling engine to that of Otto engine		1.65
Fuel saving by use of intercooling engine, per cent		22.07

For a combustion temperature of 2,000 deg. F., absolute, the above conditions are modified as follows:

	Intercooling Engine	Otto Engine
Thermal efficiency, per cent (air standard)	43.5	42.5
Maximum pressure	1,160	168
Ratio of work cycle of intercooling engine to that of Otto engine		1.30
Fuel saving by use of intercooling engine, per cent		2.3

It is apparent that for normal loading the intercooling engine possesses a decided advantage thermally. For quality governing this advantage disappears at light loads. The relations mentioned would hold in practice if both engines should, in actual operation, approach to the same degree the air-standard performance. Two questions now arise: First, What will be the probable efficiency of the intercooling engine referred to the air standard as an ideal? and secondly, What are the maximum pressures in the low-pressure cylinder? The latter condition will throw some light on the probable engine weight. The air-standard indicator diagram will suffice to show the pressure distribution throughout the cycle.

Fig. 4 represents theoretical indicator diagrams for the two cycles in which a compression pressure of 80 lb. is used in the first stage of the intercooling cycle and the total compression pressure for the Otto cycle is likewise 80 lb.

The volumes of the low-pressure intercooling cycle cylinder and that of the Otto cycle are each taken at one cubic foot and the temperature and pressure at the beginning of compression are the same in both cases. Therefore, the weight of the working fluid is the same in both cases, and since the same temperature rise is used during each combustion period, the same quantity of heat is added per cycle, the specific heat being practically independent of the pressure for the conditions given.

Under these conditions 53 per cent more work is accomplished per cycle by the intercooling engine and the ideal thermal efficiency of the cycle is 58 per cent.

A close inspection of these diagrams will, as previously stated, lead to some information concerning the probable relative weights of the two engines. Referring to the expansion curve $b'C'$, it is seen that the pressure at the point G', the opening of the transfer valve, is approximately 280 lb. per sq.in. absolute and the temperature 2,120 deg. F. The low-pressure cylinder is therefore exposed to maximum pressures somewhat less than those existing in the Otto engine cylinder. It will certainly not weigh any more than the Otto engine cylinder. The high-pressure cylinder is exposed to very high pressures, but its volume is only 17 per cent that of the low-pressure cylinder. By means of the addition of

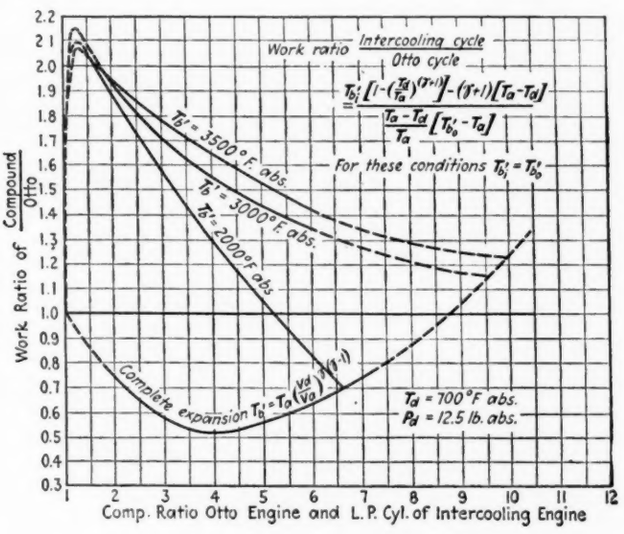

Work ratio Intercooling cycle / Otto cycle
$\frac{T_b'\left[1-\left(\frac{T_d}{T_a}\right)^{\gamma-1}\right]-(\gamma-1)[T_a-T_d]}{\frac{T_a-T_d}{T_a}[T_b'-T_a]}$
For these conditions T_b' = T_b'
T_b' = 3500° F. abs.
T_b' = 3000° F. abs.
T_b' = 2000° F. abs.
Complete expansion $T_b'=T_a\left(\frac{V_3}{V_a}\right)^{(\gamma-1)}$
T_d = 700° F. abs.
P_d = 12.5 lb. abs.
Work Ratio of Compound / Otto
Comp. Ratio Otto Engine and L. P. Cyl. of Intercooling Engine

FIG. 3—COMPARATIVE OTTO AND COMPOUND ENGINE OUTPUTS

the intercooler, high-pressure cylinder, high-pressure piston and connecting rod, 53 per cent more work is accomplished per cycle. It seems improbable that the weight of these additional parts will serve to offset the gain in power. To answer the first question mentioned, namely, What is the probable relative performance of the two cycles referred to the air standard as an ideal? will require an analysis of the engine losses.

Among the engine losses may be mentioned jacket losses, leakage, friction, expansion losses and the possibilities of poor combustion, or combustion losses.

The cylinder or jacket losses probably will be less in the intercooling cycle because the maximum temperature of the charge is no higher and during combustion and early expansion periods the gases are contained in a small cylinder in which the space occupied will be of such shape as to have probably less area per unit volume than would be the case in the Otto-cycle engine for corresponding events. Leakage would be greater in the intercooling engine because of the higher pressures. In the present state of the art, however, it should be possible to reduce the leakage losses, even for the higher pressures, to a very small fraction of the total. Frictional losses appear to be about the same for both cases.

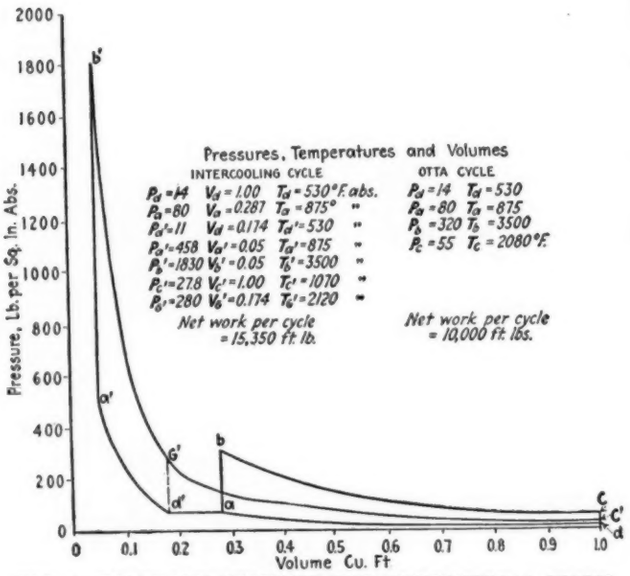

Pressures, Temperatures and Volumes
INTERCOOLING CYCLE
OTTA CYCLE
Net work per cycle = 15,350 ft. lb.
Net work per cycle = 10,000 ft. lbs.
Pressure, Lb. per Sq. In. Abs.
Volume Cu. Ft.

FIG. 4—DIAGRAMS SHOWING THE THEORETICAL WORK PER CYCLE

Under combustion losses would be included those resulting from condensation of fuel vapors because the intercooling process may have been carried too far. Any such condensation will, obviously, increase the combustion losses. This would have to be guarded against by so regulating the intercooling that the dew point is not reached. If this precaution is observed, the combustion process in the intercooling engine will be at least as good as that in the Otto engine.

Detonation May Be an Advantage

Detonation, if it should occur and cannot be avoided, may prove an actual advantage, as there is certainly a thermal advantage in having the early complete combustion accompanying detonation.

In summing up the net effect of engine losses, we may say that it is reasonable to expect that for the condition in which the thermal advantage exists by a comparison on the air standard basis, the performance of the intercooling engine referred to the air standard as an ideal will be at least as good as that of the Otto engine referred to this standard. In short the advantages shown on the air-standard basis will probably be realized in the actual engine.

Next, the question of the feasible relative costs will be briefly touched upon. The following facts are important in this respect:

1. The low-pressure cylinder will have to be no heavier in construction than the Otto-engine cylinder which it replaces.

2. The high-pressure cylinder will be of very heavy construction, but is of small size and adds more than 50 per cent to the power output of the engine.

3. There will be at least a 20 per cent saving in fuel.

When compression in a single cylinder is, by the nature of the charge, limited to pressures not greater than 100 lb. per sq.in., then the subsequent cooling and further compression will result in a decided thermal advantage.

For the conditions stated, this increased efficiency may be obtained without an increase in the weight of the engine per unit power output.

To maintain the thermal advantage at light loads, the methods of governing should be such as to maintain the original high combustion temperature.

The point of highest efficiency is not the condition for which complete expansion exists, but is considerably above this condition.

Since the engine may be operated with expansion to back pressure, the exhaust will be noiseless under these conditions.

The intercooling process is at a thermal and power disadvantage when it is not the means of increasing the final compression pressure.

Gage and Absolute Pressure

By Arthur W. Dew

We often speak or read of a "standard atmospheric pressure" or simply "standard atmosphere" as being 14.7 lb. per sq.in. What we mean, in fact, is that a column of air one inch square and extending from or near the surface of the sea, perpendicularly to a height above the earth as far as air is found, weighs 14.7 lb., and that it exerts pressure upon the surface of the earth much as would a rod of metal one inch square and weighing 14.7 lb., when placed on end upon a table.

The pressure of the air is not ordinarily physically noticeable because it acts on all sides equally. The pressure of a person's blood is equal to the atmospheric plus an amount sufficient to assure proper circulation. If one ascends to a great height quite rapidly, the outside pressure decreases faster than the inside pressure can be adjusted to the decrease and a sense of physical discomfort follows. For this reason, aviators who make sudden ascents or descents must, to lessen the danger of collapse, be able to accommodate themselves quickly to changes of pressure.

Thus, since we live continually under a pressure of about 14.7 lb. to the square inch, it is but natural that we should take this pressure level as a starting point in most of our reckoning. If we are speaking of a pressure greater that that under which we live, we speak of so many pounds gage pressure, meaning by that, so many pounds per square inch above the existing atmospheric pressure at that time and place. If, on the contrary, the pressure with which we are dealing is one less than that under which we live, we speak of a vacuum or suction pressure.

Theoretically, but never practically, it is possible to obtain a condition of absolute zero pressure. By that we mean such a condition as must exist in interstellar space—a condition in which there is no air pressure or pressure due to any other gas or mixture of gases. Such a region would be known as one of absolute vacuum. Suppose we represent *A* of Fig. 1 as such a point of no pressure and suppose, also, that our air pressure (as

determined by a barometer reading) is found to be 14.7 lb. per sq.in. as represented at *B*. Then the pressure level of *B* is that under which we are living.

It will be evident from the figure that if we are speaking of the pressure carried, say, in the boilers of our plant, and point *C* represents such pressure, we can speak of it as referred to two levels. If we reckon from level *A*, we call it absolute pressure and give the pressure as represented by *AC;* while if the level *B* is chosen for reference, we speak of gage pressure, the two values differing by an amount equal to the pressure of the atmosphere. Thus gage pressure is always less than the corresponding absolute pressure by an amount equal to the weight of a column of air one inch square and extending vertically from the point where the pressure is measured to as far above the earth as air exists. If we wish to convert the reading of our boiler gage to absolute value, we must add to it an amount represented in Fig. 1 by the distance *AB*.

Mercury is the most suitable of liquids known for gages of the manometer type; being a metal, it is much heavier than other liquids, so that considerable pressure can be measured without providing the instrument with exceptionally long legs. Thus a column of mercury

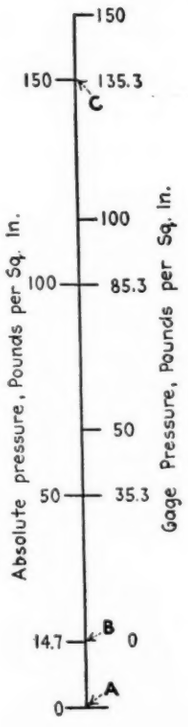


FIG. 1—COMPARISON OF GAGE AND ABSOLUTE PRESSURE

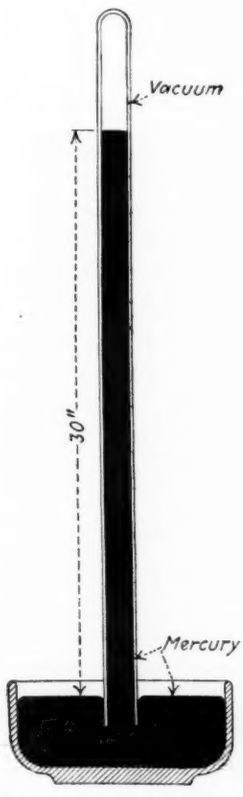


FIG. 2—SHOWING THE PRINCIPLE OF THE MERCURY BAROMETER

only about 30 in. high will counterbalance a similar column of air many miles in height.

This is the principle of the mercurial barometer, an experimental model of which can easily be made. A glass tube, closed at one end and about a yard long, is filled with mercury, care being taken that no air is left in the tube. The open end is then closed, inserted in a dish of mercury and the closure withdrawn. The mercury will sink until the column exactly counterbalances that of the atmosphere. If, now, the height of the column be measured, it will be found to be ordinarily between 29 and 30 in. above the surface of the liquid in the dish. Liquid mercury is 13.6 times as heavy as a like volume of water, a cubic foot, for instance. Since a cubic foot of water at ordinary temperature weighs 62.4 lb., a cubic foot of mercury will weigh 13.6 times

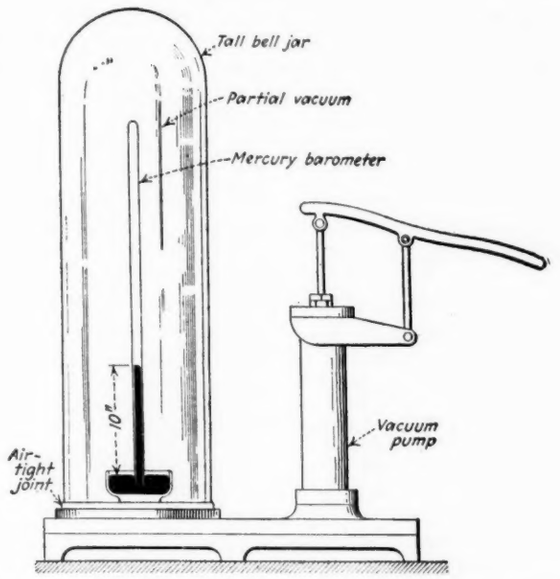


FIG. 3—A MERCURY BAROMETER ALWAYS GIVES THE ABSOLUTE PRESSURE

62.4, or 848.6 lb.; and if we have a cube of mercury exactly one foot on a side, a pressure of 848.6 lb. per sq.ft. will be exerted on the bottom of the containing vessel. The pressure will be 848.6 divided by 144, or 5.89 lb. per sq.in. It is an easy matter to figure that if a column of mercury 12 in. high exerts a pressure equivalent to 5.89 lb. per sq.in., a column one inch high will exert a pressure of 0.491 lb. per sq.in., and a column 30 in. high a pressure at its base of 30 times 0.491, or 14.7 lb. per square inch.

If we take our experimental barometer of Fig. 2, place it on the standard of a large air pump, invert a bell jar over it and begin to exhaust the air as in Fig. 3, the mercury column will be seen to fall rapidly. Suppose we exhaust the air in the jar until our mercury column is but 10 in. high. What pressure have we now within the jar? Referring to Fig. 1, it will be seen that our pressure point will lie somewhere between *A* and *B*. Correspondingly, there are two ways by which we can refer to the pressure within the jar. We can reckon from level *B* and say that the mercury column is 30 minus 10, or 20 in. shorter than ordinarily, that there is a vacuum of 20 in. within the jar when referred to a standard 30-in. column of mercury. Likewise we can say that there is a pressure of 10 in. of mercury within the jar, from which we compute a pressure of 10 times 0.491, or 4.91 lb. per sq.in. absolute.

It is clear, therefore, that the choice of gage or absolute pressure is merely a matter of whether we wish to reckon from a level of the pressure of the atmosphere or from a level of complete absence of pressure. Steam tables all use absolute pressures in stating values.

Starting Direct-Current Motors

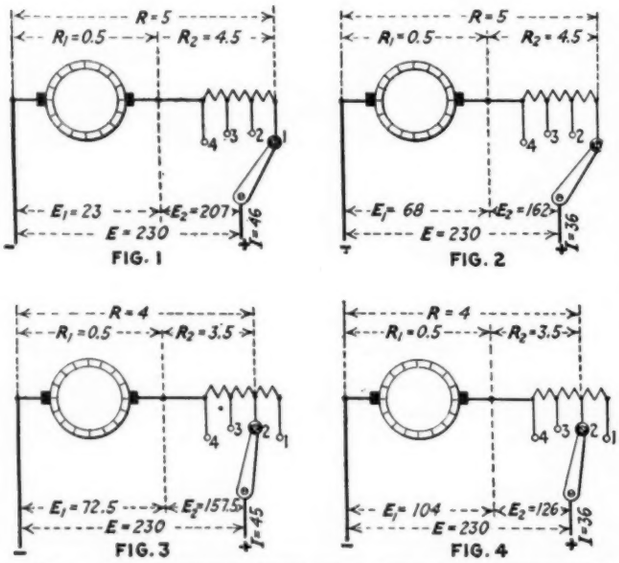
By CHARLES A. ARMSTRONG

A SIMPLE explanation is given of what happens when a motor comes up to speed and the starting resistance is cut out, and how the increasing counter-electromotive force in the armature may be used as a means of starting the motor automatically

IN THE armature of a direct-current motor the current taken from the line depends largely upon the counter-electromotive force generated in the armature conductors. Take the case of a 10-hp. 230-volt shunt motor; the resistance of the field coils may be 230 ohms and the resistance of the armature 0.5 ohm. The normal full-load armature current of such a motor would be about 37 amperes. If the field coils were connected across a 230-volt circuit, the current taken by the coils would equal line volts divided by the coil resistance, or 230 ÷ 230 = 1 ampere. If the armature, when stationary, were connected directly to line voltage, the current that would flow through it would be 230 ÷ 0.5, or 460 amperes. This current is far in excess of any value that might be expected to exist without destroying the insulation of the windings or opening the protective device.

Starting Resistance Necessary

When the armature begins to revolve, it becomes a generator and produces a voltage that opposes the applied volts, and at full speed with full load on the motor the difference between the line volts and counter-electromotive force is just enough to cause full-load current to flow. To keep the current within reasonable limits during the period of starting, it is necessary to connect a resistance in series with the armature until it begins to revolve and gradually cut this resistance out as the motor comes up to speed. The amount of resistance to be connected in series with the armature at starting will depend on the resistance of the winding, which is always low, and the value to which it is desired to limit the current.



FIGS. 1 TO 4—SHOW HOW THE VOLTAGE INCREASES ACROSS THE ARMATURE TERMINALS AS THE STARTING RESISTANCE IS CUT OUT OF CIRCUIT

Ordinarily, the starting current should not be over 125 per cent normal full-load current, or in this case 37 × 1.25 = 46.25, say 46 amperes. The amount of resistance to limit the current to this value is obtained by dividing the line volts by the starting current, or 230 ÷ 46 = 5 ohms. The resistance of the armature is 0.5 ohm, so that an additional resistance of 5 — 0.5 = 4.5 ohms must be connected in series with it if the starting current is to be limited to 46 amperes. Such an arrangement is shown in Fig. 1, where $R_1 = 0.5$, is the resistance of the armature, and $R_2 = 4.5$, is the resistance of the starting rheostat. When the rheostat arm comes in contact with point No. 1 on the resistance, a current of 230 ÷ 5 = 46 amperes flows through the armature. The volts drop across each section of the circuit is equal to the resistance of this section times the current. In this case the volts used up in the resistance is $E_2 = R_2I = 4.5 \times 46 = 207$ volts, and in the armature the volts expended is $E_1 = R_1I = 0.5 \times 46 = 23$. From this it is seen that at the instant of starting only 23 of the total 230 is effective at the armature terminals.

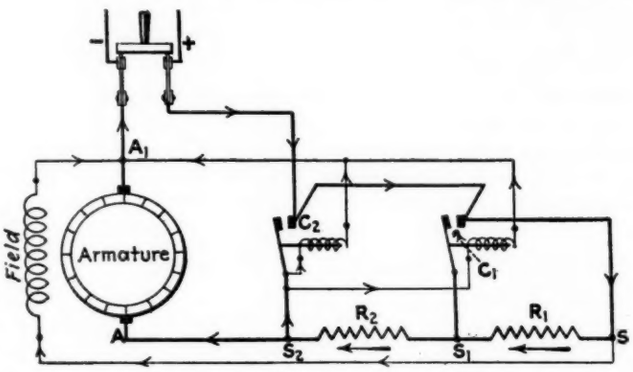


FIG. 5—SCHEMATIC DIAGRAMS OF A COUNTER-ELECTROMOTIVE-FORCE TYPE MOTOR CONTROLLER

Effects of Counter-Electromotive Force

When the motor starts to revolve, it begins to generate a counter-electromotive force. Assume that it reaches a speed where this counter-voltage equals 50 volts. Since the 230 line volts is opposed by 50 generated in the motor, this leaves only 230 — 50 = 180 volts available to cause current to flow through the motor. Therefore, the current flowing through the motor will decrease to 180 ÷ 5 = 36 amperes. With 36 amperes flowing through the starting resistance the volts drop $E_2 = IR_2 = 36 \times 4.5 = 162$ volts, which leaves 230 — 162 = 68 volts available at the armature terminals, as indicated in Fig. 2. Of the 68 volts available at the armature terminals, 18 is used up in causing the current to flow through the resistance of the armature and 50 volts is neutralized by the counter-electromotive force.

When the rheostat arm is moved onto contact 2, assume that the starting resistance is reduced to 3.5

ohms. This makes the total resistance of the circuit equal to 3.5 + 0.5 = 4 ohms, as indicated in Fig. 3. When the rheostat arm made contact with point 2, there was available 180 volts to cause the current to flow through the resistance of the circuit. Dividing the effective volts by the resistance gives 180 ÷ 4 = 45 amperes, the current that will flow under the new conditions. The volts drop across the resistance is $E_2 = R_2I = 3.5 \times 45 = 157.5$, which leaves $E_1 = 230 - 157.5 = 72.5$ volts available at the armature terminals. The increase in current will again cause the motor to speed up and increase the counter-electromotive force. Assume that the load remains constant, then the motor will increase in speed to where the counter-voltage again reduces the current to 36 amperes. When the current has decreased to 36 amperes, the volts drop in the starting resistance is $E_2 = R_2I = 3.5 \times 36 = 126$ volts. This leaves 230 — 126 = 104 volts applied to the armature terminals, as indicated in Fig. 4. From the foregoing it is seen that at the instant of starting with all the starting resistances in circuit, the voltage at the armature terminals is at a minimum, but as the motor increases in speed the counter-electromotive force increases and the applied voltage increases at the armature terminals.

Motor Operating at Full Speed

When all the resistance is cut out of the circuit, full line voltage is applied to the motor and it comes up to full speed. If the motor in question were driving full load, it would require about 37 amperes, so that the volts expended due to the resistance of the armature would be 37 × 0.5 = 18.5. This would leave 230 — 18.5 = 211.5 volts as the value of the counter-electromotive force to neutralize an equal value of line volts.

For starting the motor the resistance may be cut out by hand or automatically. When cut out by hand, the controller is designated as the manual type, of which there are a great many different forms. It is becoming

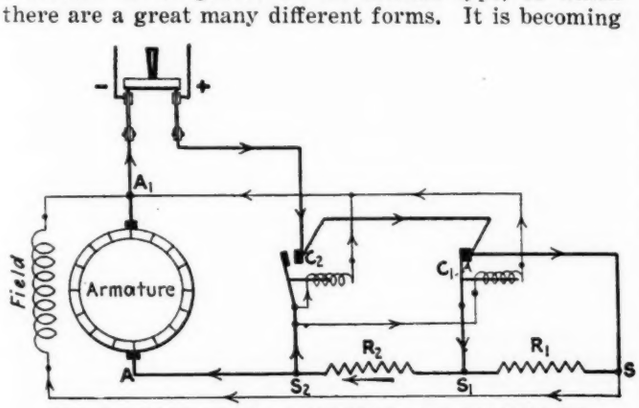


FIG. 6—SAME AS FIG. 5, EXCEPT ONE CONTACTOR IS CLOSED

more and more the general practice to start motors automatically, even in the small sizes. In the automatic controller some means must be provided for cutting the resistance out as the motor comes up to speed. This is generally done by using magnets to close switches that cut or short-circuit the resistance out of circuit, or move an arm across a row of contacts which cut the resistance out of circuit, similar to the way it is done in manual-type controllers. There are four general methods of doing this—the counter-electromotive-force, series lockout switch, series relay and time element. In this article only the counter-electromotive-force method will be discussed. The other methods will be treated in future articles.

In the foregoing it was seen that at the instant of closing the armature circuit the voltage across the armature is low (23 volts), but that as the armature speeds up, the voltage at its terminals increases owing to the counter-electromotive force increasing in value. This fact is taken advantage of to close the contactors on a controller for starting a motor automatically. Controllers designed on this principle are known as the

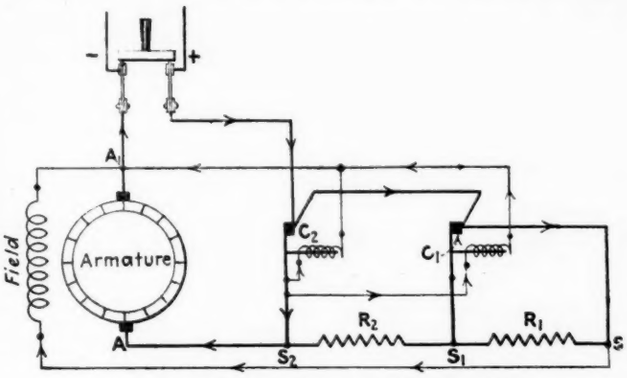


FIG. 7—SAME AS FIG. 6, EXCEPT BOTH CONTACTORS ARE CLOSED

counter-electromotive-force type, because they depend on the voltage generated in the motor's armature to produce a condition that will close the contactors to cut out the starting resistance. Fig. 5 shows a schematic diagram of a motor connected to a controller that operates on the counter-electromotive-force principle.

When the line switch is closed, current flows from the + side of the line through the starting resistance R_1 and R_2 through the armature and to the — side of the line. Another circuit is from the + side of the line to terminal S through the field winding and the — side of the line. From this it will be seen that the armature is connected across the line with the starting resistance in series and the field winding directly across the line, which is the correct condition for starting the motor. There are circuits for contactor coils C_1 and C_2, from S_2 through these two coils and to A_1 and the side of the line, which connects these coils across the armature terminals.

How Automatic Controller Operates

Assume that coil C_1 requires 75 volts across its terminals to cause it to close and that coil C_2 requires 140 volts. When the line switch is first closed and the armature is standing still, the voltage across its terminals, as shown in Fig. 1, is only about 20 or 30, so that neither C_1 nor C_2 can close. As the armature increases in speed, the voltage across its terminals increases, and when it reaches 75 volts, contactor C_1 will close, as indicated in Fig. 6. The armature circuit is now from the + side of the line switch through contactor C_1 to S_1, through R_2 and the armature to the — side of the line. This short-circuits section R_1 on the starting resistance out of the circuit and causes a further increase in the motor's speed. When the speed increases to where the voltage across the armature terminals equals 140, contactor C_2 will be closed by its coil, as indicated in Fig. 7. The armature is now connected directly across the line and the circuit is from the + side of the switch through the contactor C_2 and S_1

through the armature and to the — side of the line, which brings the motor up to full speed.

The reader should not get the idea that the current through coils C_1 and C_2 is supplied by the counter-electromotive force of the armature, since the current is supplied from the line just as in any of the other circuits. What the counter-electromotive force does is to cause the line voltage to increase across the armature terminals and decrease across the resistance as the machine speeds up. When the voltage across the armature reaches a predetermined value for which the coils are designed, there is sufficient current flowing through them to produce the necessary magnetic pull to close the contactors.

In some controllers, instead of using a number of coils to close contactors and cut out the resistances, only one large coil is used on which a number of contactors are mounted. The first contactor to close is set closest to the magnet core, so that it will close with a low voltage across the coil. The second contactor to close is set a little farther away from the core than the first and will require a somewhat higher voltage than the first and therefore will close later. Likewise for the third it is set farther away from the core than the second and requires a still higher voltage to close.

In controllers of different makes different ways of applying the counter-electromotive-force methods may be used, but the general principle is the same, and when this is understood no difficulty should be experienced in understanding the operation of any of these control equipments. The next article will discuss the series lockout type of controllers.

Selecting Ammonia Compressor Oils

By W. F. OSBORNE
Supervisor, Manufacturers' Service, Texas Co.

THE various types of ammonia compressors require different sorts of lubricants. For instance, the steam-driven compressor requires an ammonia oil for the ammonia cylinder, a steam-cylinder oil for the steam cylinder and an engine oil for the bearings. If the bearings have been designed so that they can be lubricated with a light-viscosity oil, the ammonia-cylinder oil may be used in place of the engine oil. This will reduce the number of oils required in the plant.

The motor-driven compressor requires only one oil for the entire lubrication for the ammonia-cylinder oil can be used for the bearing lubrication. When economy in initial cost of lubricants is desired and if the cylinder has a separate lubricator, a good grade of engine oil of the proper viscosity may be used for the bearings and an ammonia oil in the cylinder.

The inclosed crankcase, splash-lubricated, single- or double-acting compressor requires the use of only one kind of oil throughout, and it must be of the proper characteristics to take care of the cylinder lubrication.

Considering the ammonia cylinder, lubrication may be accomplished in a number of ways. The first thing to consider is what kind of oil is required in the cylinder, and the next thing is how to get it there in the best manner.

The ammonia vapor coming back to the cylinder from the expansion coils enters the cylinder on the suction stroke at very nearly the temperature existing in the expansion coils. This temperature depends upon the back pressure, which in turn is regulated to meet the demands of the refrigeration system. The temperature normally ranges from ten to fifteen degrees F. The entire cylinder and the film of oil upon it is exposed to this temperature for the time required for the suction stroke.

On the compression stroke the oil film is exposed to a rapidly increasing temperature, which may become as high as 300 to 325 deg. F. Owing to the conduction of heat through the cylinder wall and the piston and the alternate exposure to high and low temperatures, the oil film itself never gets very hot nor very cold, the average temperature of the film ranging from 100 to 150 deg. F., depending upon the cylinder conditions.

Under such temperatures there is likely to be very little trouble with the oil from decomposition or anything else. There is no particular need for a low pour test as far as cylinder lubrication is concerned, nor any need for a high flash test. Almost any good grade of engine oil of the proper viscosity will lubricate the cylinder and rod packing without any trouble.

With the exception of carbon deposits all the troubles that we do meet are experienced outside of the cylinder. Carbon deposits may be prevented by using a minimum quantity of oil and one which is sufficiently volatile to evaporate from the discharge valves before it has had time to decompose from continued exposure to the discharge temperatures, which may reach 325 deg. F. If the oil is too viscous it may collect on these valves, and if it does not evaporate quickly it will decompose and the resulting carbon deposit will interfere with the operation of the valves. The efficiency of the compressor is lowered and it requires more coal or more kilowatt-hours to produce a ton of ice.

The inclosed crankcase, splash-lubricated compressor sometimes presents a problem caused by emulsions. Many of these compressors have their intake valves in the piston and the crankcase itself is filled with ammonia under pressure. Even when the ammonia is not intentionally introduced into the crankcase, there is usually some leakage past the piston rings of a single-acting compressor.

Ammonia is soluble in oil to a certain extent, as may be observed by drawing off a little of the oil from the crankcase. It will foam up quickly, owing to the evaporation of the ammonia carried in solution, and in a few minutes the foam will disappear, leaving oil behind. This foaming may take place in the crankcase when the ammonia pressure has been relieved by partly closing the expansion valve and increasing the suction of the compressor. If the foaming is excessive, there might sometimes be trouble temporarily with lubrication through a failure of the foaming oil to flow to the parts requiring lubrication.

Should a slight trace of moisture enter the system from any source, the ammonia, water and oil will tend to form an emulsion. This is particularly likely to happen when the oil from an oil separator is blown back into the crankcase. This used oil is sometimes partly decomposed by the temperature of the com-

pressed ammonia and in this condition is susceptible to emulsification in the presence of moisture. The ammonia increases the tendency of the oil and water to emulsify.

The emulsions hinder the lubrication of the cylinder by preventing proper splashing of the oil, and if the oil gets too thick, "livers up," and it cannot lubricate the bearings properly. Probably, this sort of trouble can be eliminated by keeping moisture out of the oil. Practically every sample of oil that the writer has seen removed from the crankcase of a compressor on which bearing trouble has been experienced, when analyzed, showed moisture and in rare cases as much as 8 or 10 per cent.

In certain types of compressors where the ammonia is returned to the crankcase before entering the cylinder, it is possible to frost over the entire crankcase, indicating that the temperature within is below the freezing point of water. If there should be any moisture in the oil under such conditions, it is obvious that it would freeze and may prevent the proper flow of oil to the bearings and cylinder. When the oil flow is interrupted, the cylinder or bearings will overheat owing to lack of lubrication, and they may seize and put the compressor out of operation entirely.

Questions and Answers

Q. What is the correct viscosity oil to use in an inclosed crankcase compressor?

A. Most single-acting compressors can be lubricated with an oil of about 100 seconds Saybolt at 100 deg. F. Should there be any possibility of excessive leakage of oil past the piston rings, the viscosity may be raised to 150-200 seconds and the leakage reduced. On such compressors the oil is sometimes depended upon to assist the rings in preventing ammonia leakage into the crankcase, and under such conditions the 200 seconds viscosity oil will usually give best results.

Q. What pour test should be specified?

A. The pour test depends upon the temperature in the expansion coils. An oil having a pour test above zero degrees F., will seldom be satisfactory. Most suitable oils have pour tests from ten to twenty degrees below zero.

Q. What, besides moisture and emulsions, might cause the oil to thicken up in the crankcase so that it would not give satisfactory lubrication?

A. If the crankcase contains ammonia vapor under the full back pressure of the system, a certain amount of ammonia will dissolve into the oil. Should the pressure be reduced by partly closing the expansion valve, the ammonia in the oil will evaporate, lowering its temperature and causing it to foam. If the foaming is excessive, there might be failure of the oil to flow to the bearings or be splashed onto the cylinder wall in sufficient quantities to give lubrication. The bearings become hot, the small amount of oil remaining between the surfaces gets carbonized, and they may freeze together.

Q. If the exhaust steam is used for ice making, what sort of cylinder oil should be used?

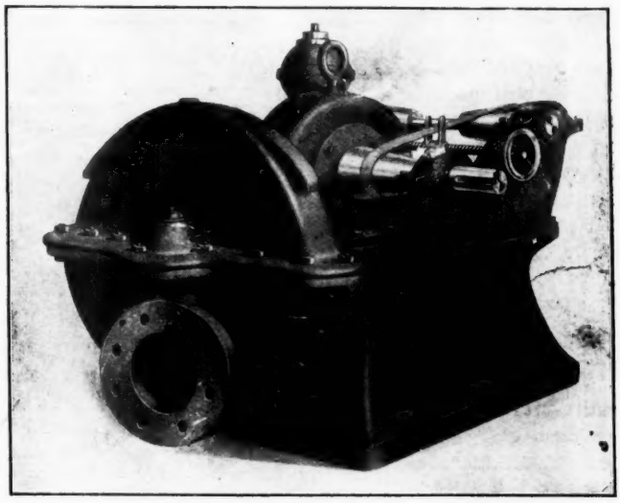
A. A filtered, straight mineral oil, containing no compounding will separate from the exhaust steam more readily than any other kind and the condensed steam can be used without trouble from yellow ice. Attention might be called to the fact that most of the yellow ice, which is blamed on the oil, is yellow because it contains rust instead of oil.

A Governor-Controlled Turbine for Stoker Drive

The principal requirement of a turbine designed for stoker drive is high torque at low speeds, to prevent stalling in case of obstruction in the stoker.

This requirement has been met in a new governor-controlled turbine, which may be operated at low speed, as with hand control. Should any obstruction tend to stall the turbine, the governor valve would immediately open wide, giving full steam pressure behind the jets. Subsequent removal of the obstruction would cause speeding up until the governor again came into action, automatically throttling the turbine to the desired speed.

The governor of this turbine is driven through a cone-and-belt variable-speed transmission, whose belt



LONDON TURBINE FOR STOKER DRIVE

may be shifted either by a handwheel, as shown, or by means of an automatic control. The speed range of the main drive shaft is 100 to 400 r.p.m.

Other features of the turbine, which is made by the London Steam Turbine Co., Troy, N. Y., are the use of but two ball bearings on the turbine shaft (there being no outboard bearing), the use of worm-and-gear drive from turbine shaft to main drive shaft, and the absence of soft-packing stuffing boxes. Oil is pumped from a main reservoir in the base of the casting to an upper reservoir, completely submerging the worm. Thence it flows to the main bearings, through fine clearances between shaft and casing which pass no more than the right amount of oil for bearing lubrication. From the bearings the oil flows by gravity back to the main reservoir.

In addition to the steam jets used for ordinary operation, a set of extra-large, hand-controlled auxiliary nozzles provides a considerable increase in power for starting up a new, stiff stoker, or for use in case of extremely low pressure.

In Great Britain a number of cities have central stations for supplying water at pressures of 700 to 1,600 lb. per sq.in. to factories and docks, for the operation of slow-acting but powerful machinery, such as presses, elevators and cranes, requiring great preciseness of regulation with only intermittent applications of power.

The Advantages of a Large Ammonia Condenser

By L. C. MILLER

THE three main considerations in the selection of an ammonia condenser for a given plant are capacity, cost (considered from all angles), and the limitations imposed by the operating conditions in the place where the condenser will be installed.

It goes without question, of course, that the condenser must be of sufficient capacity to serve the machine to which it is connected, but there is a wide latitude of choice, even in this matter. Where the initial temperature of the water is low, a condenser of given size will often do three times the amount of work that it will do in another case where the water is excessively high in temperature and limited in quantity.

The item of cost is intimately connected with that of capacity. It is possible to install a condenser unit of small surface and low first cost, but this means an increase in the power cost of operating the machine and, in most cases, increased cost of water. A liberal-size condenser will enable the machine to be operated at a lower discharge pressure, or a reduced water consumption for the same condenser pressure. This of course means a reduction in the operating cost but an increase in the first cost, and of course an increase of the interest charge and other overhead items on the investment. The condenser that will have the minimum combined overhead and operating cost is the proper condenser to install.

Capacities and horse-power per ton refrigeration of one section counter current double pipe condenser, 1¼" and 2" pipe, 12 pipes high, 19 feet outside water bends, for water velocities 100′ to 400′ per minute. Initial temperature of condensing water 70°.

High Pressure Constant

Condensing Water				Capacity in Tons Refrig. per 24 hrs.	Condensing Pressure Lbs. per sq. in.	Horse-Power per Ton Refrigeration		
Velocity through 1¼" pipe Ft. per min.	Total Gallons used per min.	Gallons per min. per Ton Refrig.	Friction through Coil Lbs. per sq. in.			Engine Driving Compressor	Circulating Water through Condenser	Total Engine and Water Circulation
100	7.77	1.16	2.28	6.7	185	1.71	0.0016	1.7116
150	11.65	1.165	5.75	10.	185	1.71	0.004	1.714
200	15.54	1.165	9.98	13.4	185	1.71	0.007	1.717
250	19.42	1.18	15.	16.4	185	1.71	0.011	1.721
300	23.31	1.24	21.6	18.8	185	1.71	0.016	1.726
400	31.08	1.30	37.8	24.	185	1.71	0.030	1.74

Capacity Constant

100	7.77	0.777	2.28	10.	225	2.04	0.001	2.041
150	11.65	1.165	5.75	10.	185	1.71	0.004	1.714
200	15.54	1.554	9.98	10.	165	1.54	0.009	1.549
250	19.42	1.942	15.	10.	155	1.46	0.018	1.478
300	23.31	2.331	21.6	10.	148	1.40	0.030	1.43
400	31.08	3.108	37.8	10.	140	1.33	0.071	1.401

Notes:—Above tables are based on the Heat Transmission obtained for various velocities of water, as averaged up from York Manufacturing Company's tests on double pipe condensers.

The horse-power per ton is for single-acting compressor and 15.67 lbs. suction pressure.

The friction in water pump and connections should be added to water horse-power and to total horse-power.

Nov. 14, 1907.

CAPACITY OF DOUBLE PIPE CONDENSERS

Overhead is made up of (1) interest on the investment, generally 6 to 7 per cent; (2) depreciation, which will vary from 8 to 15 per cent, depending upon the type of condenser, operating conditions and the kind of water used; (3) taxes, insurance, etc., which will vary with the locality; (4) maintenance, from 1 to 5 per cent; (5) and ammonia losses, from 1 to 10 per cent, depending upon the type of condenser and the care given to its maintenance.

Operating costs, as far as the condenser is concerned, are made up of (1) power or steam cost for operating the compressor or the absorption machine; (2) the cost of the water, including the cost of pumping.

The accompanying tables from tests published by the York Co. show very plainly what can be expected from a double-pipe condenser. With a constant condenser pressure of 185 lb. the capacity varies from 6.7 tons to 24 tons according to the quantity of water passed through the condenser. The power required under these conditions varies from 1.7116 to 1.74 total horsepower per ton.

By operating the condenser at a constant capacity of 10 tons, the condensing pressure varies from 225 to 140 lb. according to the quantity of water passed through the condenser, while the total horsepower requirements vary from 2.041 to 1.401 horsepower.

A study of the tables will show that for maximum capacity from a given condenser it should be operated at a high condenser pressure and a maximum quantity of water forced through the condenser. To insure operation with a minimum water consumption requires a large-sized condenser and high condensing pressures. Minimum power consumption requires a large-sized condenser and the highest possible quantity of condensing water.

Take a concrete illustration. Assume in the first case that the plant is situated in one of the large producing oil districts where crude oil can be used at very small cost for operating the power unit. We will further assume that the plant requires the same crew whether the refrigerating machine is installed or not. Practically the only operating charge that enters into this consideration will then be the cost of fuel, and we will assume that this can be obtained at a cost of 0.1 cent per horsepower.

By operating at a condenser pressure of 225 lb. and circulating the water through the condenser at a velocity of 400 ft. per min., the capacity of the condenser of the dimensions given in the table can be increased to approximately 34 tons. The capacity of the condenser will be seen to vary approximately with the temperature difference between the initial temperature of the condensing water and the condensing temperature of the ammonia. For a pressure of 185 lb., the

condensing temperature is about 96 deg., or 26 deg. above the initial temperature of the condensing water. For a pressure of 225 lb. the condensing temperature is approximately 107 deg., or 37 deg. above the initial temperature of the condensing water. Assuming that the capacity of the condenser varies with the temperature difference, it is increased 1.42 times when the condensing pressure is raised from 185 lb. to 225 lb. At a velocity of 400 ft. per min. through the condenser, of the condensing water, the capacity of the condenser at 185 lb. pressure is, from the table, 24 tons. Multiplying this by 1.42, we get approximately 34 tons for the higher condensing pressure.

Operating with High Pressure

In connection with the new plant we will further assume that the water is obtained from a flowing artesian well that delivers the water to the pump at sufficient pressure to compensate for the friction losses in the piping connection from the pump to the condenser. We will assume that this well has been drilled for another purpose and the water that is used for the refrigerating machine would otherwise go to waste or would not be available for any other purpose. Under these circumstances there will be only the charge for pumping the water through the condenser chargeable to the refrigerating machine.

The required capacity of the plant is 100 tons per 24 hours for 100 days, or a total of 10,000 tons per year. By operating the plant at 225 lb. condensing pressure and circulating the water through the condenser at a velocity of 400 ft. per min., the capacity of the condenser will be approximately 34 tons if the condensing water enters at an initial temperature of 70 deg. as determined by the previous calculation. Under these conditions three stands of the dimensions given in the tables will produce the required 100 tons capacity.

On account of operation at this high condensing pressure, the depreciation, maintenance and ammonia loss charges against the condenser will be maximum. Assuming 12 per cent for depreciation, 5 per cent for maintenance, 10 per cent for ammonia losses, 2 per cent for taxes, and 7 per cent for interest on the investment, the total overhead charge on this condenser will be 26 per cent of the original investment.

The cost of this condenser will be approximately $750, and in round figures 26 per cent of this will be approximately $200. In other words, the overhead charge on this particular condenser under the operating conditions given will be about $200 a year.

From the tables it will be seen that 2.04 hp. will be required to operate the compressor at 225 lb. condensing pressure and that approximately 0.02 hp. is required for circulating the condensing water per ton of refrigeration. This makes a total of 2.06 hp. per ton, or a total of approximately 50 hp.-hr. per ton per 24 hours. For a total of 10,000 tons a total of 500,000 hp.-hr. will be required.

At a cost of 0.1 cent per horsepower-hour the cost for power per year would be $500. The total cost, including overhead charges on the condenser, will be $700, which is the total cost for the service per year of operation, assuming that it operates only 100 days, which often happens in certain classes of service.

Assume, again, that the condenser is operated at 140 instead of 225 lb. pressure, all other conditions remaining the same. Which method of operation is the most economical on a commercial basis?

At 140 lb. condensing pressure the capacity of the condenser will be 10 tons per stand of the dimensions given in the table. The total number of stands required for the 100 tons will be ten. These will cost approximately $2,500.

At the lower condensing pressure the depreciation, maintenance and ammonia loss charges will be considerably reduced. Assuming a maintenance charge of 4 per cent, ammonia loss about 7 per cent, depreciation 10 per cent, interest 7 per cent and taxes and insurance 2 per cent, the total overhead charge will be 20 per cent, or $500 a year.

Referring to the tables, we find the total horsepower per ton for both compressor and water circulation, at 140 lb. condensing pressure and a velocity of the water through the condenser of 400 ft. per min., to be 1.401. This is equivalent to $24 \times 1.401 = 33.6$ hp.-hr. per ton. For the season's run it would be $10{,}000 \times 33.6 = 336{,}000$ hp.-hr. At a cost of 0.1c. per hp.-hr. the power cost per year would be $336.

The total cost for the year would be the sum of the overhead charges and the power cost, or a total of $\$500 + \$336 = \$836$ a year. As previously determined, it will be remembered that for operation with three stands of condenser and at 225 lb. condenser pressure the total cost for the year was only $700, so that this particular installation and conditions of operation will show a saving of $136 a year as compared to a condenser having 10 stands and operating at 140 lb. condensing pressure.

Suppose, however, that the power cost is 3c. per hp.-hr. and that the machine is operated at full capacity for 300 days per year. This will produce a total of 30,000 tons per year.

Using the same data as in the preceding problem, with the exceptions noted, we found that it required approximately 50 hp.-hr. per ton for operation with three stands and 225 lb. condenser pressure. For 30,000 tons there would be required 1,500,000 hp.-hr. At 3c. per hp.-hr. the power cost per year would be $45,000, and the total cost, including overhead charges on the condenser, would be $47,000.

For operation with 10 stands at 140 lb. pressure, the power requirements will be 33.6 hp.-hr. per ton, or a total of approximately 1,000,000 per year which at 3c. per hp.-hr. would cost $30,000 a year for power. The total cost, including overhead charges on the condenser, is $35,000 a year. This shows a saving in favor of the larger condenser of $12,000 a year. In this case a still larger condenser would be a worth-while investment.

There is another interesting item in connection with these tables. By checking the horsepower per ton of refrigeration required to circulate the water through the condenser, it will be noted that it varies roughly as the cube of the quantity of water circulated. In other words, when the velocity is increased four times, from 100 ft. to 400 ft. per min., which also means a four times increase in the quantity circulated, the horsepower per ton for water circulation is increased from 0.001 to 0.071. Now the cube of 4 is 64, so that it will be seen that the power requirements for water circulation follows approximately this cube of the increase in velocity.

Suppose, now, the velocity is made 500 ft. per min., the velocity would be increased $500 \div 400 = 1.25$ times, and of course the quantity in the same proportion. The power requirements for water circulation would be increased approximately as the cube of the increase in quantity, and the cube of 1.25 is approximately 2. By

referring to the table, we also find that the power consumption is increased approximately two times for every 25 per cent increase in the quantity of water circulated, so we can assume that this rule will be approximately correct.

By a study of the tables we find also that the power consumption of the compressor is reduced from 1.54 to 1.40 hp. when the circulation is increased 50 per cent, or a net reduction of 0.14 hp. By an increase of 33 per cent in circulation, from a velocity of 300 ft. per min. to 400 ft., the power consumption of the compressor is reduced to 1.33 hp., or a net reduction of 0.07 hp. It will thus be noted that while the power for circulating the water is increasing as the cube of the increase in quantity, the power reduction for the compressor becomes practically insignificant. For a 25 per cent increase in water circulated, the reduction in power requirements for the compressor will probably be less than 0.05 hp. at this point, while the power for circulating the water will be increased 0.07 hp. or more. From this it appears that at a velocity of 400 ft. per min. the savings in power requirements for operating the compressor by increasing the velocity of the water is practically offset by the increased power requirements for circulating the water.

New Flow Meter Uses Tilting U-Tube

The familiar U-tube manometer has been used in a novel way in the flow meter and recorder illustrated on this page. Instead of taking the difference in level in the two arms of a stationary U-tube as a measure of the flow, the makers have suspended the tube on a knife-edge, like a beam balance, and thus have arranged to measure the flow by the amount the tube tilts due to the rise of mercury in the low-pressure arm and the corresponding fall on the high-pressure side. The tilting U-tube, indicating pointer and recording mechanism are all contained in the circular case shown in Fig. 1.

The use of a tilting U-tube does away with the "stuffing-box problem" arising when the attempt is made to transmit the motion of a float in one arm of a stationary U-tube, under pipe pressure, to an external recording mechanism, under atmospheric pressure. However, with the tilting tube another problem arises—how to connect the two halves of the tube with stationary pipes leading to the high- and low-pressure sides of the orifice in the pipe whose flow is being recorded. The makers have solved this problem by using for high- and low-pressure leads two ⅜-in. copper tubes, placed

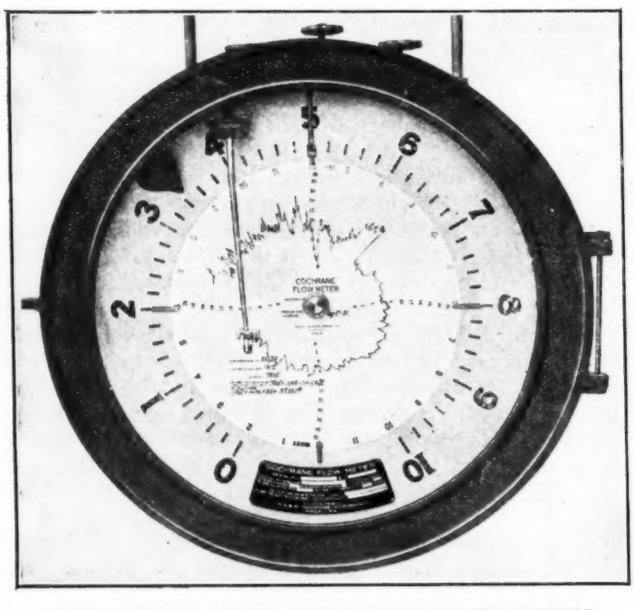


FIG. 1—FLOW METER WITH UNIFORM INDICATING AND RECORDING SCALES

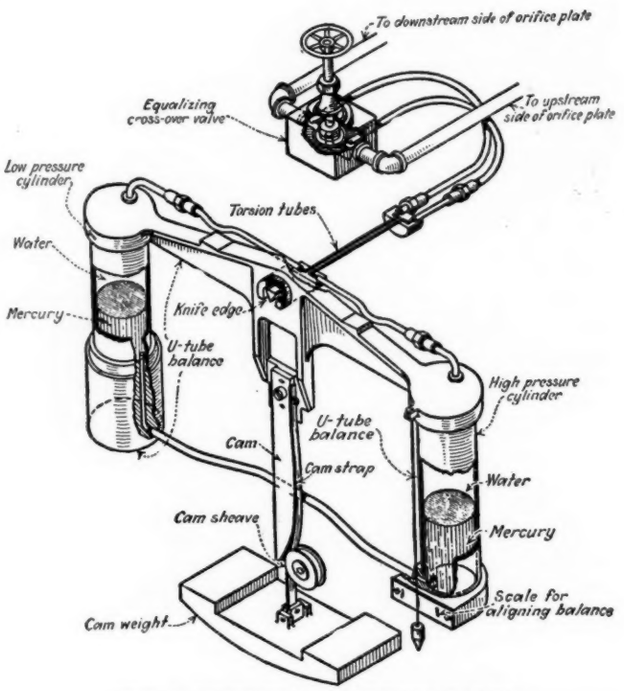


FIG. 2—ESSENTIAL WORKING PARTS

Perspective view, showing torsion tubes, tilting manometer and rectifying cam. The indicating and recording mechanism is omitted.

parallel to and close to the axis of rotation, as shown in Fig. 2. These tubes are placed in torsion when the U-tube tilts.

Another problem arising in the design of such a flow meter is that of obtaining uniform indicating and recording scales. According to the well-known law of liquid flow, the pressure difference—and therefore the amount of tilt of the U-tube—is proportional to the square of the rate of flow in the pipe. Therefore, a freely tilting U-tube would have larger divisions on its scale for the higher rates of flow than for the smaller. To obtain scales uniform throughout the entire range, a cam and weight are used, as shown in Fig. 2, the cam being so designed as to have a greater and greater retarding effect as the angle of swing increases. The forces due to torsion of the pressure leads are also taken care of by this cam.

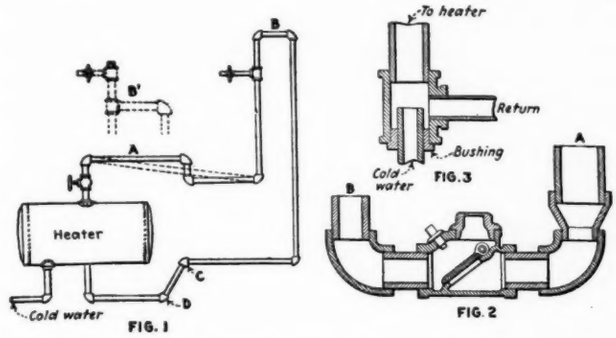
Since an indicating pointer and scale large enough to be visible the length of the boiler room are desirable, the small swing of the U-tube is magnified, through a gear and sector, so that the indicator covers a circular scale of 300 deg., with a total linear travel of 42 inches.

This flow meter is made by the H. S. B. W.-Cochrane Corp., Philadelphia, Pa., and is supplied with a sharp-edged flat orifice plate, as standard equipment. The pressure connections to the two sides of the orifice are carried through the plate itself, so that the location of the high- and low-pressure openings is always correct, and the coefficient of discharge for the orifice is a fixed quantity for a given size of pipe.

Hot Water Distribution by Natural Circulation

By H. M. PHILLIPS
Electrical Aid, Public Works Department, Navy Yard, Washington, D. C.

THE engineer who finds himself responsible for the installation of a system of hot water distribution in which circulation is dependent upon the temperature difference of supply and return should give sufficient care and study to the design and installation of the equipment to insure satisfactory operation. It is



FIGS. 1, 2 AND 3. FAULTY HOT WATER SYSTEM. WATER POCKETS AND REVERSED FLOW OVERCOME BY PIPING CHANGES

true that many installations are so simple that they can hardly fail to be satisfactory; it is equally true that there are quite a number of installations made where preliminary calculations would have shown that there could be no hope of success. There are other layouts where even the best engineer cannot state positively whether or not the desired circulation will be maintained, and which should be avoided by as large a margin on the side of safety as the circumstances will permit.

It must be borne constantly in mind that the actual pressure or head available to cause circulation is exceedingly minute, under even the most favorable circumstances, and that a correspondingly minute opposition to the flow, which would be insignificant in most other cases, is sufficient to prevent circulation. Air pockets are a fruitful source of trouble; a faulty installation is illustrated in Fig. 1. A certain amount of air is certain to be liberated when water is heated, and its first tendency is to form a pocket at *A*; this, however, is not a very serious matter as it will be pretty well cleaned out when any large quantity of water is drawn from the faucets; some bubbles may remain, if the pipe is of comparatively large diameter, which would reduce the effective diameter of the pipe, and therefore the flow under natural circulation; it is preferable to avoid such a pocket if practicable. Although in the illustration an air pocket is formed by the use of fittings, it should be borne in mind that an almost equally effective pocket may be formed by even a slight grade in the pipe, as shown by dotted lines; by preference the pipe should always have a little rise that will allow air to flow to a point where it may escape. Air that has passed the pocket *A* will naturally rise to the pocket *B*, where there is no means of escape, and it will only require a little more than enough to fill the short horizontal section in order to cut off the circulation entirely. There is no hope for such a system as this, but in the present case the fault is readily corrected by changing the connections as shown by dotted lines at *B*; air will then be drawn off whenever the faucet is used. There is very little chance of air being drawn down from *B* to *C* or liberated from the water in the lower sections of pipe, but if any does find its way to the lower section, where the circulation is never rapid, the slight slope of the pipe forms a pocket at *C* which will cut off circulation. The lower leg should slope in the same direction throughout, so that the air will either rise to *B* or pass on to the heater. An air bubble at this point would be slow in forming, and if no other remedy is available a pet cock could be inserted at *C* and air drawn off at long intervals or a valve at the top of the heater may be closed and a strong stream of water forced through the return pipe, in the reverse direction, by opening several faucets; unless this method is followed, some air is likely to be trapped at *C* when water is first turned into the empty pipes.

Correcting Reversed Flow

With the installation as shown in Fig. 1, all pipe being assumed to be of the same size, opening the faucet would result in drawing almost as much cold water from the bottom of the heater as hot water from the top; with the quite common practice of using a smaller pipe for the return, the flow of cold water would still be objectionable. The obvious remedy is a check valve

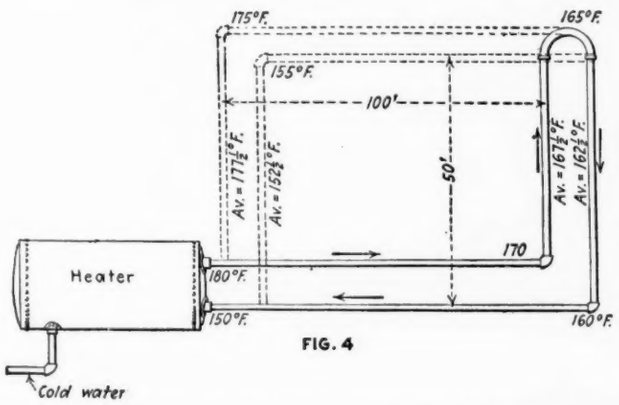


FIG. 4. DOTTED LINES SHOW CHANGES TO INCREASE CIRCULATION

in the return pipe, but the pressure required to lift the disk of a check valve, although insignificant in ordinary pipe work, is frequently greater than that available to cause circulation; the check valve will then cut off the circulation as effectually as a globe valve. The pressure necessary to overcome the resistance of a check valve may be roughly determined by connecting one as shown in Fig. 2. Let the nipple *A* be about 3 inches higher than *B*, allow water to flow into *A* at about the

rate that it may be anticipated to pass the valve in order to give the needed circulation, and measure the vertical distance between the overflow and the height at which the water stands in *A*; this will probably be found to be between 1 and 2 inches which, as will be seen below, is a greater head than will ordinarily be obtained in service. To overcome this difficulty, the check valve may be installed at an angle of 45 deg., as at *D* in Fig. 1, so as to allow the valve disk to hang partially open. This will allow a certain amount of back flow, but the valve will be closed by the current if the amount reaches serious proportions. In some cases this will cause the valve to pound while water is being drawn, although as a rule no trouble is experienced; if the piping layout lends itself to such an arrangement it may be better to install the valve at about 30 deg., which will usually let the disk hang just clear of the seat. Another

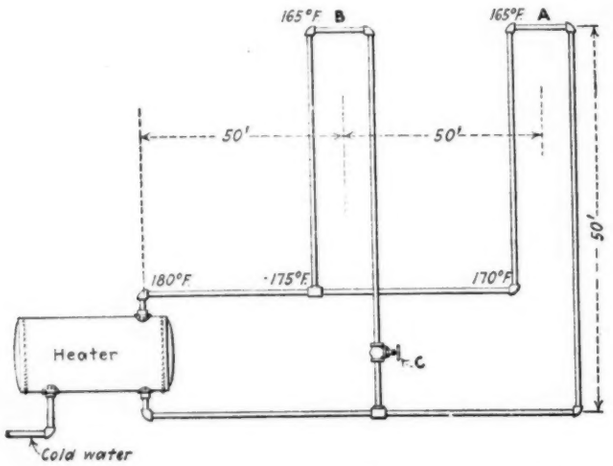


FIG. 5. ADJUSTING FLOW BY MEANS OF THROTTLING VALVE

device, which may be used as a substitute for the check valve or as an auxiliary to it, is shown in Fig. 3; in this case the incoming cold water acts as an ejector, producing a suction on the return pipe that should be sufficient to prevent back flow. In ordinary cases a small amount of back flow is of no consequence, as it is quite probable that the call for hot water will cease before the cold water reaches the faucet, or that the water will still be sufficiently hot after having its temperature reduced by the cold water.

The probability of successful operation is increased by having the vertical run of pipe, or as much of it as possible, in the immediate vicinity of the heater. In Fig. 4 the problem is to supply hot water to a point 50 ft. above the heater and 100 ft. from it in a horizontal direction. Running pipe as shown by full lines is in many cases the only feasible method, but the circulation will be much better if run as shown by the dotted lines. Assuming that both the hot water and return pipes are of the same diameter and that water circulates at such rate that the temperature fall is 10 deg. F. per 100 ft.; water in the heater at 180 deg. F. would give a return at 150 deg. in either case; the temperatures at the various points are indicated in the illustration. Following the full lines, the average temperatures in the vertical legs are 167.5 deg., and 162.5 deg., giving a difference of 5 deg. to produce circulation, which may perhaps prove inadequate. With the dotted lines the averages are 177.5 deg. and 152.5 deg., with a difference of 25 deg., giving five times the circulating pressure obtained in the first case. Even a few feet of vertical pipe close to the heater, such as may be obtained by placing the heater near the floor instead of near the ceiling, are decidedly valuable. Circulation may also be increased by covering the hot water pipe and leaving the return pipe bare; the temperature fall will then be about four times as rapid in the return as in the supply, with a corresponding increase in the temperature difference between the two pipes. On the other hand, leaving both the hot water supply and return uncovered greatly reduces the chances of satisfactory operation. Assuming the heat loss from uncovered pipes to be four times as great as from covered, it will require four times the amount of circulation to maintain the same temperatures and to obtain four times the flow would require approximately 16 times the amount of circulating pressure; but as the temperatures are assumed to be the same, there is no increase in circulating pressure available.

It is quite common practice to make the return pipe smaller in diameter than the supply, which is an economy in installation and therefore good engineering so long as satisfactory operation is assured. The probability of obtaining the desired circulation is materially reduced by this procedure. The amount of heat loss is approximately proportional to the surface of pipe involved; the fall of temperature in the return pipe will therefore be less than in the supply, which means a reduction in the available circulating pressure. At the same time, the pressure necessary to maintain the flow is increased on account of the smaller diameter of the pipe.

How to Determine if Circulation will be Satisfactory

To determine whether or not satisfactory circulation will actually be obtained under any given condition (as in Fig. 4) it is necessary to assume the minimum allowable temperature at the point *A* and the maximum at the heater; these will be taken for illustration as the same values shown on the drawing. The difference in pressure caused by temperature difference in the vertical legs is approximately 0.00014 lb. per ft. per deg. difference of temperature, which in the present case

CALCULATED FLOW FOR STANDARD WELDED PIPE

Pressure in lb. per sq.in. per ft. of length

Nominal Pipe Dia., In.	.0010	.0008	.0006	.0004	.0002	.0001	.00008	.00006	.00004	.00002	.00001
	Gallons per minute										
¾	.515	.462	.396	.326	.231	.163	.146	.126	.103	.073	.0515
¾	.891	.798	.690	.564	.398	.282	.252	.218	.178	.126	.0891
1	1.78	1.60	1.38	1.13	.800	.564	.505	.437	.388	.253	.1785
1¼	3.53	3.16	2.73	2.23	1.58	1.12	.995	.863	.755	.497	.353
1½	5.63	5.04	4.36	3.57	2.52	1.78	1.59	1.38	1.13	.795	.563
2	10.5	9.42	8.14	6.65	4.72	3.33	2.98	2.57	2.11	1.48	1.05
2½	17.0	15.2	13.2	10.8	7.61	5.38	4.81	4.16	3.40	2.40	1.70
3	29.7	26.6	23.0	18.8	13.3	9.42	8.43	7.29	5.96	4.20	2.97

gives a total of $50 \times 5 \times .00014 = 0.035$ lb. The amount of circulation necessary to maintain these temperatures may be calculated on the assumption that ¾-in. bare pipe is used for the entire system, and that the surrounding air has a temperature of 60 deg. F. The loss of heat from uncovered pipe is approximately 2.71 B.t.u. per sq.ft. per hr. per deg. difference of temperature between pipe and air; 3.64 ft. of ¾-in. pipe gives one sq.ft. of external surface; the average temperature of the pipe between heater and point *A* is 172.5 deg.; the heat loss

in this section is therefore (150 ft. ÷ 3.64) × (172.5 — 60) = 4,636 B.t.u. per hour. The water loses 15 deg. to supply this heat, which calls for a circulation of 4,636 ÷ 15 = 309 lb. per hour, or 0.618 gal. per min. The question now becomes, Will the available circulating pressure produce this amount of flow? With available data it is probably impossible to calculate the flow with any great degree of accuracy. The table, based upon Darcy's formula, should serve fairly well in cases like the present. The diameters given are the nominal diameters of standard pipe.

In the case under consideration, we have 0.035 lb. per sq.in. for 300 ft. of pipe, or 0.00012 lb. per ft.; by reference to the table it will be seen that the flow will not be much more than 0.282 gal. per min., about half that required for the desired temperatures. Besides the assurance that we will be unable to obtain 165 deg. of circulating water at the faucet, a number of conclusions may be drawn from these data without repeating calculations: Insulating the pipe will give the same temperatures with approximately one-fourth the circulating water, which should cause the system to work satisfactorily and at a temperature somewhat above 165 deg. Running the pipe as shown by dotted lines gives about five times the circulating pressure and will cause a flow of 0.690 gal. per min., fulfilling the requirement but leaving a rather narrow margin. If 150 deg. at the faucet will suffice, only half the circulating water will be required and the circulating head doubled; reference to the table shows that this will leave a fair margin of safety; in fact, the temperature will be brought somewhat above 150 deg. Substituting 1-in. for ¾-in. pipe would cause just about the required amount of flow as figured here, but as the heat loss is slightly greater for the 1-in. pipe, the temperature loss would fall slightly more than before and we would not quite attain the 165 deg. mark, but would probably approach quite close to it; for greater accuracy the calculation may be repeated for 1-in. pipe.

Although the figure 0.00014 lb. per deg. per ft. is sufficiently accurate at the usual working temperature, there is considerable error if it is used for unusually high or low temperatures; it may therefore be well to consult the following table in exceptional cases.

PRESSURE IN POUNDS PER SQUARE INCH PRODUCED BY A COLUMN OF WATER ONE FOOT HIGH

Deg. F.	Lb. per Sq.In.	Deg. F.	Lb. Per Sq.In.	Deg. F.	Lb. per Sq.In.	Deg. F.	Lb. per Sq.In.
210	.4158	170	.4222	130	.4274	90	.4312
200	.4175	160	.4236	120	.4285	80	.4321
190	.4192	150	.4250	110	.4396	70	.4326
180	.4207	140	.4263	100	.4306	60	.4331

It will be noted that between 150 deg. and 170 deg. the difference in pressure is 0.0014 lb. per sq.in. for each 10 deg.; between 200 deg. and 210 deg., 0.0017 and between 60 deg. and 70 deg. 0.0005 lb. per sq.in.

Determining Conditions in Two Branches

With two or more hot water lines connected to one main, as in Fig. 5, the situation becomes slightly more complicated, but a rough approximation of the performance may be made without much difficulty; if the apparent margin of safety is so small as to leave doubt of the result, additional calculations may be made as previously explained. In Fig. 5, consider that circulation in the branch *B* is cut off by means of the valve *C*; if satisfactory circulation is then obtainable in the branch *A*, it is certain it will also be obtained in *B* when the valve is opened, the question being to what extent *B* will rob *A*. As the temperature at the foot of *B* with the valve closed is 175 deg. and will become slightly higher, owing to increased circulation as the valve is opened, only one-half the water that is required for branch *A* need circulate; branch *B* may be throttled accordingly. Any addition to the total flow in the main will increase the loss of pressure due to friction in the section between the heater and branch *B*, and therefore increase the pressure required to maintain the original flow in branch *A;* the flow in branch *A* will therefore be slightly reduced when branch *B* is in operation. This decrease, if serious in amount, may be overcome by increasing the size of the mains up to the branch *B* or by leaving the return of branch *A* without insulation while applying it to the rest of the system.

It has been shown that with branch *B* disconnected, the normal flow in branch *A*, with temperatures indicated, produces a circulating pressure of 0.035 lb. per sq.in. for the entire system of piping; one-third of this pressure must be consumed in causing the flow between the heater and branch *B*. Twice the temperature drop is available in branch *B*, so if it is one-sixth the height of *A* the pressures will be balanced, with no surplus to cause flow in *B*. An adequate flow would probably be produced if *B* were 10 ft. high.

Setting the Eccentrics of Steam Engines

By Thomas W. Airey

To most operating engineers the marking off and setting of the eccentrics on the crankshaft is considered a very important piece of work, although in most modern machine shops the marking off and definite setting are

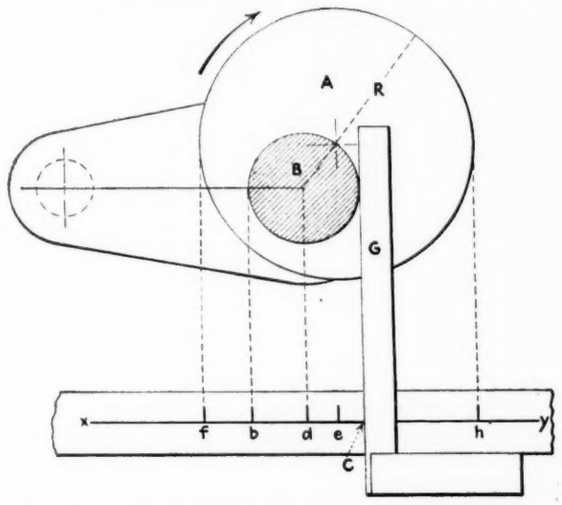


FIG. 1—LAYING-OFF THE VALVE LAG AND LEAD

no longer left to the mercy of the engineer, jigs being provided for the machinery of the eccentric to the required throw and a templet for the keywaying, also fixtures giving the correct position for the keywaying of the crankshaft. By this means not only are production costs lowered, but liability to error is also minimized. Still there are times when the engineer is called upon to execute this very important piece of work in the field.

A common practice with some engineers for setting the eccentrics on the crankshaft is shown in Fig. 1.

It is assumed that the eccentric is on the shaft and that the latter is resting in the bearings. Set the crank horizontally true; take a straight-edge and place it horizontally level below the eccentric as shown in the figure and support it by any convenient means. On the straight-edge and parallel to its edge mark the line *XY*. With a square *G*, the edge of the blade being in touch with the shaft and the back of the square true to the edge of the straight-edge, scribe a line cutting the line *XY* at *C*. Then with the square set to touch the shaft on the opposite side scribe a line at *b*; bisect the two points *C* and *b* at *d*. This will represent the center of the crankshaft. From *d* mark a point *e* so that *de* equals the lap plus lead the valve is to have. From *e* as a center mark the line *f* equal to half the full diameter of the eccentric, with the same setting of the compass mark the line *h*. Then $ef = eh$ and *fh* is the full diameter of the eccentric. With the square, the back resting true with the straight-edge and the edge of the blade *G* set to touch the line *h*, move the eccentric around on the crankshaft until its periphery comes in touch with the square as shown in Fig 2. If the square is used in a similar

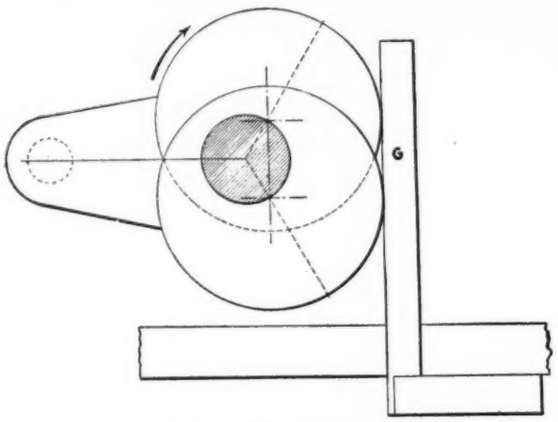


FIG. 2—LOCATING THE ECCENTRIC POSITION

manner on the opposite side, the periphery of the eccentric and the line *f* should coincide. The eccentric is then in its correct position on the shaft and the keyway may be marked off. In the present example the rotation of the crank is assumed to be in the direction of the arrow, but if the crank rotation is in the opposite direction, the markings on the straight-edge would be precisely the same, but the position of the eccentric throw line *R* would require to be on the opposite side of the crank pin or below a horizontal line through the shaft center. If two eccentrics are used, as in link motion, the setting lines are applicable to both.

Should the two eccentrics be in one casting, then all that is necessary is to move them on the crankshaft until the peripheries of both coincide with the edge of the square blade as shown in Fig. 2.

This method fails unless the engineer observes extreme care in the measuring. With the position thus determined, it is only necessary to key the eccentric into place and with the crank at dead center adjust the valve rod so that the valve has the lead desired. In many instances where the eccentric has slipped, it is easy to reset it by placing the engine on dead center and shifting the eccentric to give the required lead, checking to see that the two leads are equalized.

Rotary Furnace-Wall Plate Cuts Down Clinkering

A rotary plate set in an arched recess in the side wall of a stoker-fired furnace, at the point exposed to the greatest heat, is shown in the accompanying illustrations. It was designed to keep down the formation of clinker and thus to reduce furnace-wall deterioration. Driven from the stoker crankshaft through a rod, ratchet and gear, the plate revolves slowly, so that the

FIG. 1—ROTARY FURNACE-WALL PLATE AS IT LOOKS ABOVE THE GRATE

clinker that tends to collect on the wall at this point is constantly scraped off against the adjacent grate blocks. Two plates are used per furnace, ordinarily, one in each side wall.

The plate is made up of a number of renewable sectors of tile or cast iron. It is mounted on a horizontal shaft in the air chamber below the grate, and only about two-fifths of its area projects above the grate blocks. Thus there is no possibility of overheating the plate, as its rotation constantly presents a

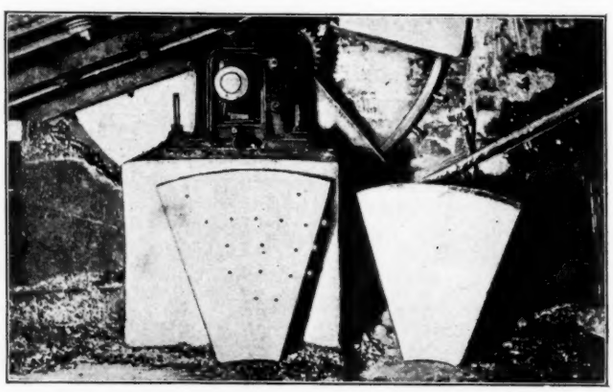


FIG. 2—SHOWING SECTIONAL CONSTRUCTION AND MOUNTING OF PLATE IN THE AIR CHAMBER

new surface to the heat of the fire and carries to the air chamber below the surplus heat which ordinarily causes a destructive "welding" of molten firebrick and clinker at this point. The circulation of air in the recess behind the plate further assists in reducing the temperature. The driving rod and gear are visible in the lower view.

The device is handled by the E. & M. Engineering Co., 50 Church St., New York City, and has been successfully used at the Port Morris power station of the New York Central Railroad.

Replacing Cables on a One-to-One Traction Elevator Machine

By F. A. ANNETT, Associate Editor, *Power*

IN THE September 5 issue a method of replacing the cables on a two-to-one traction elevator machine was described. This same scheme may be applied to replacing the cables on one-to-one machines. One-to-one traction elevator machines may be roped up in three ways, depending on the type of machine and its location. When the machine is located overhead, which is generally the case, the roping may be as in Fig. 1 or in Fig. 2. In Fig. 1 the cables pass from the car over the traction sheaves, then around the idler and traction sheaves and to the counterweight. This type of machine is frequently referred to as a double-wrap machine. In this case the cables run in semi-circular grooves in the sheaves and traction is obtained by the friction between them and the sheave.

On the machine shown in Fig. 2, the cables pass from the car over the traction sheave and directly to the counterweight. When this type of machine was first built, a V-shaped groove was used in the traction sheave, which gripped the cable sufficiently along with the friction existing between the sheave and cable, to give the necessary traction. For that reason this class of machine has become known as the V-grooved type. However, in these machines as they are constructed today, various shaped grooves are used, and they are frequently referred to as single-wrap machines.

If the machine is located in the basement, which is seldom the case, some such scheme of roping as shown in Fig. 3 is used. In all three cases it is seen that the car and counterweight speeds are the same as that of the cables, which means that the traction-sheave speed must be slow, around 70 revolutions, to maintain the speed of the car within reasonable limits.

The method of replacing the roping on any one of these machines is the same and is much simpler than for the two-to-one type. First the counterweight is bottomed so that the top of the car will come about level with the top-floor landing. Then two planks are placed, one on each side of the counterweight guide rails at some convenient position above the top of the car, such as indicated at *C*, Fig. 4. Then the car is raised sufficiently to take the tension out of the cables and the clamping device *A* placed on the cables on top of the planks on the guide rails, as explained in the previous article, after which the car is raised about one foot. This retains practically all the slack over-

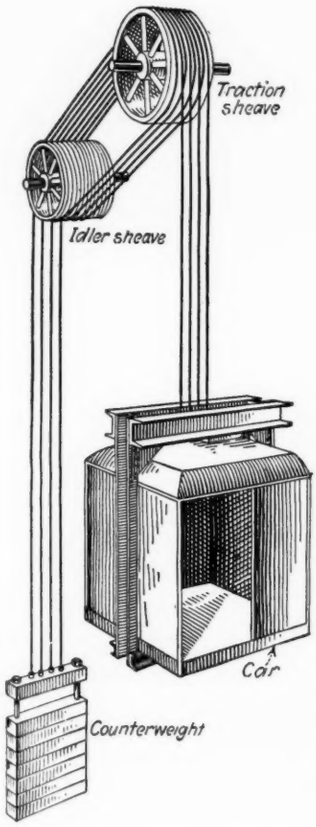


FIG. 1—DOUBLE-WRAP TRACTION ELEVATOR MACHINE

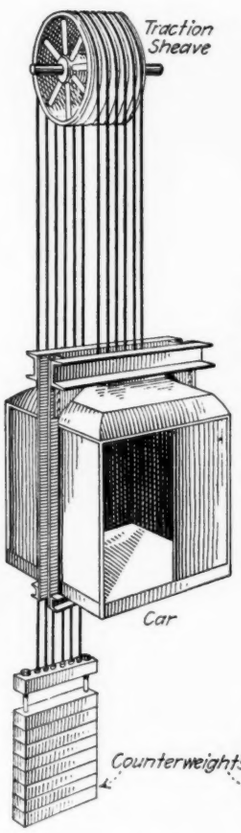


FIG. 2—SINGLE-WRAP TRACTION ELEVATOR MACHINE

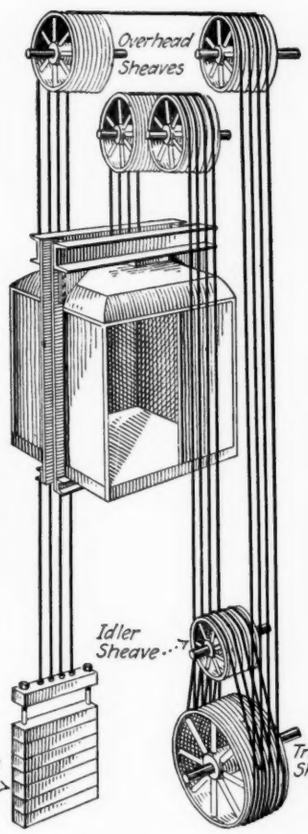


FIG. 3—BASEMENT-TYPE TRACTION ELEVATOR MACHINE

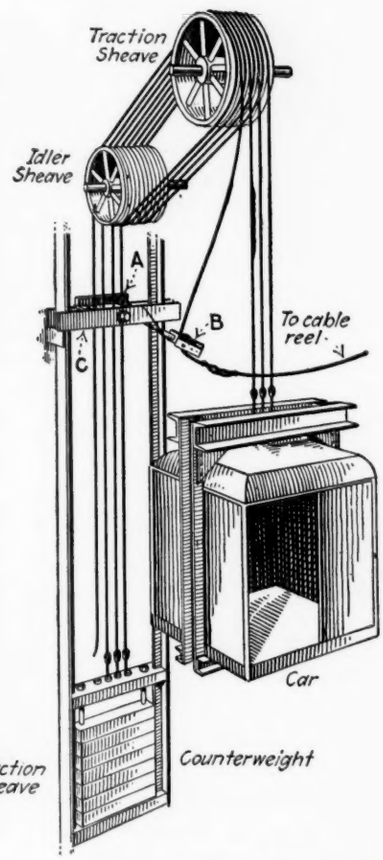


FIG. 4—NEW CABLE ATTACHED TO OLD ONE READY TO BE RUN-ON

head, so that the cables may be tied clear of the sheaves while the new ones are being run on. A pulley for guiding the new cables is attached to the planks, as indicated at *B* in Fig. 4.

If the machine is of the direct traction type—that is, with the traction sheave mounted on the motor shaft—the brake may be blocked open and the cables run on by hand, but it will be found easier in any case to run them on with the motor. Furthermore, a better control of the operation will be obtained and a lot of hard work avoided. Therefore it is best to block all contactors on the controller open except the potential switch and up-direction magnet and tie the car switch in the up position and operate the machine from the limit switch on top of the car as explained in the Sept. 5 issue.

The shackles are removed from the ends of the first cables to be renewed and the new cable married to the car end of the old one. It is then placed in the guide pulley *B*, Fig. 4, and the slack taken up on the reel, all the other cable having been tied clear of the sheaves. The cable is released from the clamping device, the machine started from the limit switch and the cable run on until there remains about ten feet on the reel, when the cable is again gripped in the clamping device and the remainder run off the reel by hand.

After taking the cable off the reel, the shackle is put on and put in place on the car, after which the cable is released from the clamping device and allowed to run over all but about one foot, when the clamp is again put on. The one foot of slack allows lifting the cables from the sheaves and tying them up so that they will not interfere with running on the others. The counterweight end can be allowed to hang free in the shaft until all the cables are run on, after which the cables are lowered onto the sheaves and the slack allowed to run over to the counterweight. To allow for stretch, the new cable should be cut about a foot shorter than the old ones.

Preventing the Cables from Twisting Around Each Other

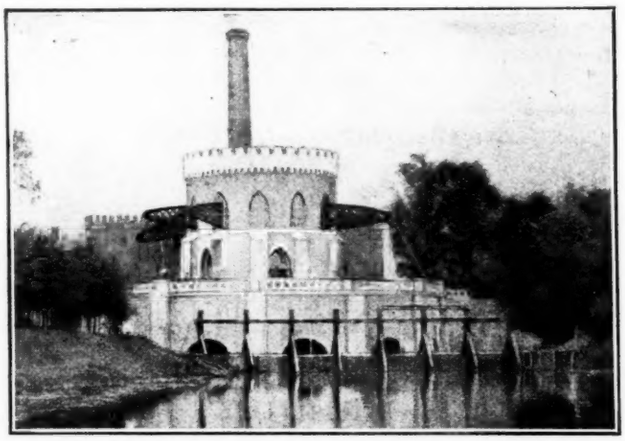
Care must be exercised to prevent the cables from being twisted around one another. This can be done by tying a stout cord to the first cable that is put on, and then tying each successive cable to this as they are run on. If this is done at the counterweight end and on top of the traction sheave, there should be little trouble from misplaced cables. After all the cables are on, the clamping device is removed from the counterweight rails and the car lowered until it is carried on the cables. All cables should be given the same tension, and if they are all pulled over from the car alike, cut the same length at the counterweight and the shackles adjusted to the same length, little trouble should be experienced in equalizing the load on them.

What applies to the double-wrap overhead machine also applies to the basement-type machine, Fig. 3, or the overhead single-wrap machine, Fig. 2. Many of the details of the work not discussed here were given in the Sept. 5 issue, but there are many other details that each crew must work out for themselves, according to the conditions involved.

Work is being done at Pittsburgh, Pa., by the United States Bureau of Mines on a portable method for determining the dissolved gases in boiler-feed water, especially hydrogen. Some boiler-feed waters have been found to contain more than 30 per cent hydrogen.

An Old Dutch Pumping Station

One of the three pumping stations that seventy years ago converted Lake Haarlem (Holland) into 684 square miles of fertile soil is retained in its original state and occasionally used for stand-by service. Steam is generated at 30 lb. in boilers of the Cornwall type and is used in primitive beam engines made in England. The beams extend through the power-house walls, as shown, the pumps being placed around the building. A number of screens, shown in the foreground, keep



PICTURESQUE OLD PUMPING STATION IN HOLLAND

out dirt and other foreign matter. The water is discharged into a canal that encircles the lake proper, whence it flows to the North Sea.

The other two Lake Haarlem stations have been equipped with modern pumping machinery and are operated chiefly during the fall and spring months in order to keep the drained area free of water. There are many of these small installations in Holland, driven by steam, gas or oil, the majority being isolated plants like the one pictured on this page.

Insulation of Furnace Walls—A Correction

Fig. 1 of the article on "The Insulation of Furnace Walls," by H. T. Matthew, in the Aug. 8 issue, gave curves for the relative conductivity of firebrick, red brick and insulating brick up to 2,200 deg. F. A footnote stated that the curves were "plotted from Bureau of Standard Tests." The accuracy of this statement having been called into question, *Power* has taken the matter up with the Bureau of Standards and is informed by the Director, Dr. S. W. Stratton, that the Bureau has never tested the thermal conductivities of insulating materials at temperatures above 200 deg. F.

The most accurate method of determining the total heating value of a coal sample is by combustion in a bomb calorimeter, states the Bureau of Mines in Bulletin 193, just issued. The instrument should be carefully standardized by burning substances of known calorific value, such as the standard samples of cane sugar, naphthalene, and benzoic acid, that are now being furnished by the Bureau of Standards. The standardization should be conducted under exactly the same conditions and with the same thermometer that is used in the tests.

EDITORIALS

The Power Show

THIS is an age of power. Few realize how completely the maintenance of civilization upon its present plane depends upon power, artificially produced.

The process of its production and distribution is not one to awaken wide general interest, although there is a story to it as fascinating as any romance. The reappearance in the furnace of the sunlight of forgotten ages, the battle of the molecules as the boiler plates, held together by their own molecular attraction, are bombarded by molecules thrown off from myriads of planetary systems of water molecules, as they break up under the urge of increasing velocity or temperature, the conversion of the inconceivably swift and erratic motion of these myriads of particles to the quiet and orderly motion of the steam engine or turbine furnish themes of interest to others than engineers.

The Power Show which is to be held at the Grand Central Palace December 7 to 13, immediately following the Annual Meeting of the Mechanical Engineers, will appeal most strongly to the engineer, and especially to the engineer who is concerned with the production of power, and to those industrial managers whose interest is broad enough to include this department of their works. All sorts of power-plant machinery, appliances and supplies will be shown, and a special effort is being made to have the exhibits operative, demonstrative and educational. The various engineering societies concerned with power are represented upon its Board of Directors, of which I. E. Moultrop, a power-plant engineer of national prominence, is chairman. Held virtually as a feature of the fall meeting of the A.S.M.E., to which Society it bears the same relation as does the Chemical Show to the American Chemical Society, and accessible to many engineering societies within striking radius of New York, it will bring the inventors, manufacturers and purveyors of the constituents of the power plant into contact with probably the largest audience of the users of such material ever assembled. This propinquity ought to result in the wider and more intelligent application of efficiency-producing apparatus and a better knowledge by users of what is to be had and how to apply and handle it.

We hope that it may be so pronounced a success as to become an annual occurrence.

Using One's Spare Time

IN VISITING small and moderate-sized power plants, one observes in too many instances engineering publications and textbooks lying on the engineer's desk thick with dust from lack of use. To the inquiry as to why the wrappers have not been removed from the pile of magazines, the answer is frequently a plea of lack of time. Engineers who follow this habit are making a grievious mistake.

Attending to the thousand and one little details of plant operation is tiring. The repair and adjustment of the machinery in many cases takes much of the engineer's time and physical strength. After the day is over he can hardly be blamed if he goes to the movies in preference to spending an hour or two in the perusal of the current engineering magazine. In so doing, however, he is limiting his field of usefulness to himself.

In regard to that part of the plant operation that requires nothing but physical strength no higher-grade man is needed than the one unloading the car of coal or working in the ditch in the street. For this kind of employment no one can expect a greater financial return than the average wage for unskilled labor. If the engineer hopes to increase his income, it cannot come by the use of his physical powers, but is obtainable only by the use of brain power.

While amusements such as the movies may provide momentary enjoyment, in the long run the hour spent on studying engineering pays more. If a man has the proper interest in his work and is looking ahead, the time spent over any publication devoted to his needs should not be wearisome but decidedly pleasurable While one may make a so-called living from following any line of work, one cannot hope for much else unless the work appeals.

Preventing Insulation Failures in Electrical Machinery

IT HAS long been realized that oil is one of the worst enemies of electrical-machinery insulation. If oil is allowed to get on the commutator continuously, a short-circuit either between the bars or from one or more bars to ground will eventually result. Where oil gets on the coils, similar effects are produced. These failures have been going on ever since the introduction of electrical equipment and have been accepted very largely as a matter of course, without any serious thought being given to what proportion of electrical machinery defects were due to this cause.

Last year the Standardization Subcommittee of the Association of Iron and Steel Electrical Engineers sent a questionnaire to twenty-five of the largest steel plants, asking for information on motor failures. The data obtained show that thirty-seven per cent of alternating-current motor and forty-one per cent of direct-current motor failures are due to oil. This indicates that if oil could be kept away from the machine's insulation an average of forty per cent of the failures could be avoided. Of course all motors are not subjected to the severe conditions of a steel mill, nevertheless oil gets on the windings and causes many insulation breakdowns.

Lubricating of electrical machinery, especially small-sized equipment, is apparently such a simple operation that in most cases the proper attention has not been given to it. Pouring oil into the bearings at stated intervals or when somebody happens to think about it is not conducive to smooth running. If the motor has well-designed sleeve bearings with oil rings, is located in a fairly clean place and the service is not severe, such treatment might not result in trouble for a considerable period. However, in many cases such a practice has caused motors to be in the repair shop a considerable

part of the time. If a suitable grade of lubricant is selected and properly applied and the bearings kept clean so that the oil can circulate, it will do much to keep the oil away from the insulation.

Ball or roller bearings have been suggested as a means of preventing oil from the bearings getting on the windings. Doubtless much of the trouble experienced with ball bearings in motors in the past has been due to their being designed too light for the service to which they were applied, in order to keep the cost comparable with that for a sleeve bearing. Operating men have estimated that from seventy-five to ninety-five per cent of motor failures due to oil can be prevented by the use of anti-friction bearings, and if this be the case, there can be no competition between the two types of bearings on a cost basis. All that is necessary is to design the anti-friction bearing large enough to meet service conditions, and the reduction in maintenance cost and increased service factor will pay handsome dividends on the investment.

An Awakening in the N. A. S. E.

A PROMISING feature of the recent convention of the National Association of Stationary Engineers, evidenced not so much by the recorded proceedings as by the attitude and utterances of the delegates, was an apparent conviction that the Association is not living up to its opportunities.

The N. A. S. E. purports to be an educational institution. The preamble of its constitution declares that "at all times preference shall be given to education and to securing the enactment of engineers' license laws."

At the convention just past more than twenty-nine thousand dollars was spent for mileage for the delegates; some twelve thousand dollars was appropriated for salaries, officers' expenses and committee work, and of it the Educational Committee got four hundred dollars.

Less than one per cent of the annual expenditure is directly assigned to carrying out the principal avowed object of the Association.

The N. A. S. E. is forty years old. Less than a dozen of the forty-eight states have engineers' license laws applying to the type of engineer composing the association. Obviously, the association has not been very effective in attaining its second avowed object.

During the twoscore years of its existence the N. A. S. E. has enjoyed an opportunity unique in the history of industry. The number of horsepower employed in the industries of the country has increased from 2,185,000 by the census of 1879 to 20,064,961 by the census of 1919. This does not include railroads, mines, central electric stations, electric railway stations, office buildings, hotels and many other power-using institutions the plants of which exceed in magnitude those of many factories. A conservative estimate of the power production of the country for purposes exclusive of railroads and mining is fifty million horse.

But of more import than this increase in volume is the greater increase in complexity. The power plant of today has become a composite, the intelligent and efficient operation of which demands much more of its operator and offers much greater opportunities to its manager than did the simple steam plant of a half-century ago. It is to the everlasting credit of the N. A. S. E. that many of the men that this development has called for owe their knowledge of the fundamentals and the acquirements that have fitted them to operate and manage these aggregations of new inventions and appliances to the interest kindled, to the study habits acquired and the facilities for self development afforded by their work in local associations of the N. A. S. E.

But what an unexploited opportunity there has been and is yet for some energizing, directive and contributory work by the National body!

Some desultory work, good of its kind, there has been, it is true, by the National Educational Committee. The failure of the membership to react to it and participate interestedly in it indicates that it did not appeal to the existing need.

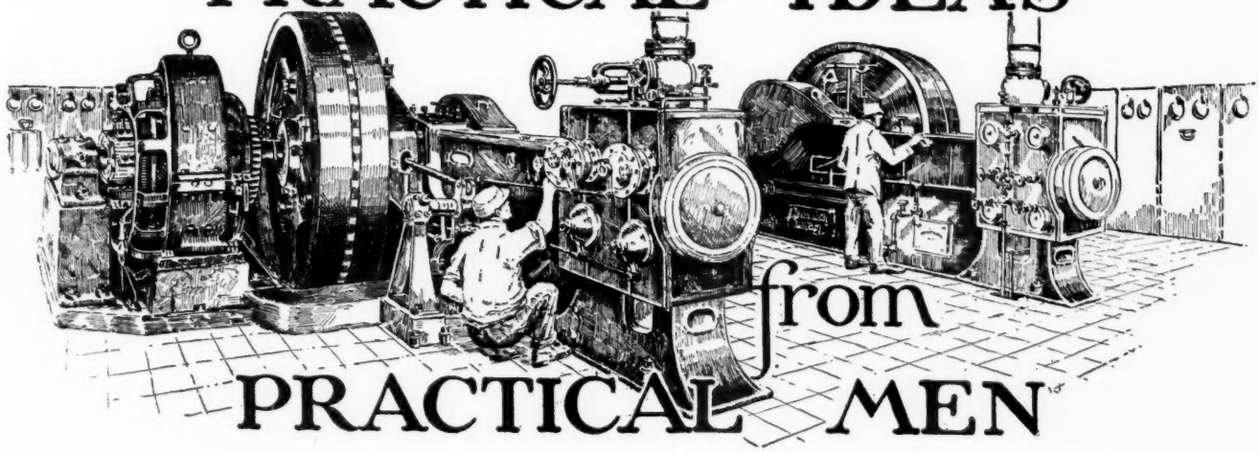
The membership embraces a wide range in age and experience, in mental capacity and educational equipment, in desire for further knowledge, willingness to work for it, and opinion or preference as to the kind of knowledge required. No one course of study, of lectures, of questions to be answered, will appeal equally to or meet the needs of the whole membership. There is an opportunity here for a trained educator to study the field, to find the various kinds of knowledge and information and mental training the need of which is indicated, to prepare such of these as are capable of being acquired by home study in an easily assimilated textbook form, with plenteous examples showing their application to the daily occupation of the student, and to impress by illustrated lectures and the discussion of experienced members, a knowledge of the structure, adjustment and operation of concrete apparatus.

If the association is to make a real effort for the enactment of engineers' license laws, a continuing committee with terms long enough to enable its members to become wise in the subject should have a collection of all the laws in force upon the subject and inform themselves as to their respective advantages and weaknesses in operation. It should have immediate knowledge of all attempted legislation and offer suggestions as to desirable modifications and helps in obtaining its passage. It should make a study of the motives behind the opposition to such laws and of the best means of overcoming such opposition. It should inform itself with regard to the engineers' license laws for civil and professional engineers which have recently been a matter of so much concern to the professional engineering societies and which, as adopted by several states, appear to affect the power-plant engineer of large responsibilities. They should get into active co-operation with the Uniform Boiler Law Society, which seeks the adoption of uniform boiler-inspection laws by all the states, as this legislation and the departments executing it are often linked closely with the engineers' examination bureaus.

There is opportunity for a lot of intelligent and effective work on these two subjects, but it will cost some money. The income has been spent in keeping the Association alive, in vitalizing the means without much progress toward the end. Would not the N. A. S. E. kindle with a new interest if real systematic intensive education, leading to a professional engineering equipment, were made available to its members and its application made a part of their meetings, and if they could see real and successful effort being put into the attainment of the legislation which they desire?

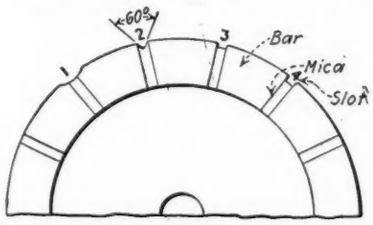
The convention inspired the hope that the membership and the leaders are getting the vision of the possibilities that the Association affords. Let us hope for its substantial progress toward the new ideal.

PRACTICAL IDEAS from PRACTICAL MEN



Undercutting Commutators

Direct-current motors are often required to operate in places where there is considerable dust, lint or moisture in the air. If the motor is not inclosed in a dust- or moisture-proof housing, these materials come in contact with the commutator and in time cause considerable trouble, especially to those that are undercut, unless some provision is made to keep the slots from becoming filled with these substances. It often happens that small quantities of oil or grease come in contact with the commutator, which work into the slots. As the brushes wear, small particles of carbon dust, copper or brass become embedded in the grease. The metals, together with leakage currents which are set up, may soon attack the mica and cause it to lose its insulating properties. Obviously, the best way to prevent this action from taking place, is to keep the slots clean. By properly undercutting the commutator, its speed and centrifugal force may be used to accomplish this end.



DIFFERENT TYPES OF SLOTS USED IN UNDERCUTTING COMMUTATOR MICA

The figure shows a method of undercutting that has proved satisfactory for commutators exposed to oil and moisture, with a peripheral speed of less than 1,500 ft. per min. The illustration is exaggerated for the sake of clearance. A piece of a small rat-tail file will make approximately the right curvature for the slot, shown at 1. This method leaves the mica low and removes a small portion of the copper from the edge of the bar.

For a commutator speed around 1,500 ft. per min. No. 2 slot shows a satisfactory method of undercutting so that the slots may be kept clean. The angle should be about 60 deg., and little if any of the copper should be removed. For a speed of 3,500 ft. per min. No. 3 shows the desired slot. It should be cut $\frac{1}{32}$ in. deep and with a tool that will not tear the mica. The edge of the commutator bar should be slightly rounded. For speeds up to 5,000 ft. per min. the slot shown at 4 may be used. It is cut like No. 3 except deeper—approximately $\frac{1}{64}$ in. The edge of the bar should be rounded a little more than No. 3.

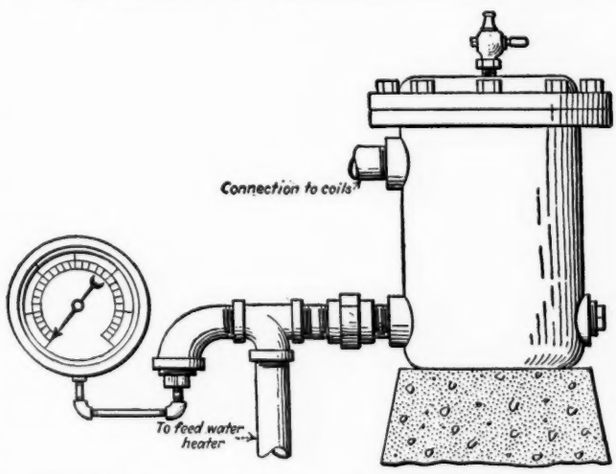
It is not advisable to use a lathe tool for undercutting a commutator. The tool soon becomes dull, and even while sharp it tends to tear the mica. A fine-tooth hacksaw is a good implement for the purpose. All portions of the finished slot should be perfectly smooth and show no signs of injured mica. It is in the small cavities caused by undercutting that much of the deterioration of the mica starts.

H. A. ROSE.

Manhattan, Kan.

Keeping Tab on Operation of Steam Trap

The engineer in charge of an absorption refrigerating system in a small cold-storage plant, experienced considerable trouble with a low-pressure steam trap used for discharging the condensation from the steam coils in the generator of the apparatus. The trap was unreliable in operation and caused frequent flooding of the generator coils and consequent lowering of the condenser pressure.



PRESSURE IS SHOWN ON GAGE AT EACH DISCHARGE OF TRAP

In order to have a check on the operation of the trap, a gage was connected to the discharge pipe as shown in the sketch. When the discharge valve opens, the momentum of the discharging water causes a momentary pressure in the gage connection and a sudden upward swing of the gage pointer. The gage is located where it may be observed readily by an

attendant, and as it discharges at intervals of about three minutes when working properly, with ordinary vigilance any lapse in the periodic movement of the pointer will be noticed. A. J. DIXON.

St. Louis, Mo.

Complications Due to Lead

Where there is lead (or angular advance, as many call it), the functions of the ordinary slide valve are influenced. For instance, it makes admission, cutoff, exhaust and cushion come sooner, without altering the duration of any one of them; and in either calculating or construction in solving slide-valve problems, complication is introduced.

Naturally, this means that if we wish to cut off at the same point with lead as without, we must alter the steam lap; that is, decrease it. The problem, "How much lap under the changed conditions?" is somewhat less simple than where there is no lead.

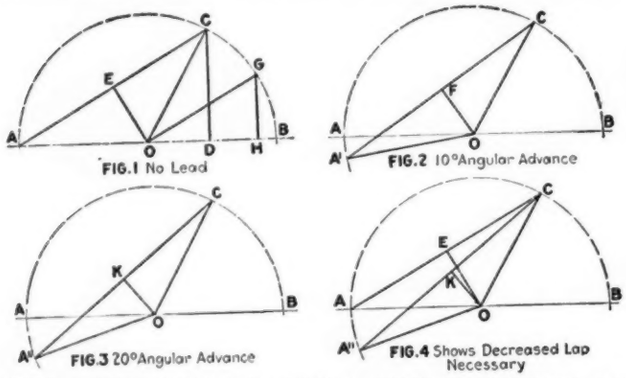


FIG. 1 No Lead. FIG. 2 10° Angular Advance. FIG. 3 20° Angular Advance. FIG. 4 Shows Decreased Lap Necessary

FIGS. 1 TO 4—VALVE DIAGRAMS, SHOWING EFFECTS OF LEAD ON THE STEAM-LAP REQUIRED

Let us look at Fig. 1, in which cutoff is at crankpin position *C*, piston position *D* (valve-travel and piston stroke being represented on the same diagram, on different scales).

With admission at stroke end *A* we have steam lap *EO* equals *GH* (the latter being the sine of the crank angle *BOC*).

But with admission at *A'*, as in Fig. 2, where there is 10 deg. angular advance of the eccentric, we have only *FO* as lap.

If *BOC* is 60 deg., then with a valve travel of 2 in. the lap *EO* equals *GH* in Fig. 1 would be the sine of half *BOC*, being equal to 0.5 in; and for a 6-in. valve travel it would be 0.5 times 3, or 1.5 inches.

In all these diagrams the ratio of the lap to the valve travel is represented by the formula,

$$\frac{1}{2}\times\frac{\sin 180\text{ deg.} - 120\text{ deg.}}{\sin\frac{120}{2}} = \frac{1}{2}\times\frac{\sin 60\text{ deg.}}{\sin 60\text{ deg.}} = \frac{1}{2}\times\frac{0.86603}{0.86603} = 0.5;$$

that is, it would be 1.5 as before.

But with lead angle *AOA'* of 10 deg., as in Fig. 2, we now have the ratio,

$$\frac{1}{2}\times\frac{\sin 180\text{ deg.} - 130\text{ deg.}}{\sin\frac{130\text{ deg.}}{2}} = \frac{1}{2}\times\frac{\sin 50\text{ deg.}}{\sin 65\text{ deg.}} = \frac{1}{2}\times\frac{0.76604}{0.90631} = \frac{0.84523}{2} = 0.42262$$

so that the lap would be 0.42262 times 3 = 1.2678 (Fig. 2).

Suppose that by reason of very small ports and the necessity of excessive speed increase, we give another 10-deg. lead; then we have the ratio,

$$\frac{1}{2}\times\frac{\sin 180\text{ deg.} - 140\text{ deg.}}{\sin\frac{140\text{ deg.}}{2}} = \frac{1}{2}\times\frac{\sin 40\text{ deg.}}{\sin 70\text{ deg.}} = \frac{1}{2}\times\frac{0.64279}{0.93969} = \frac{0.68402}{2} = 0.34201.$$

Then 0.34201 times 3 = 1.02603, which is the lap necessary with 20 deg. lead, if we wish to keep the cutoff at the same point.

In Fig. 4 we have parts of Figs. 1 and 3 combined for comparison.

How Can the Ash Dust Be Eliminated When Using Steam-Jet Conveyors?

We have recently put into operation in our plant, a steam-jet ash conveyor. The ashes are discharged into an overhead bunker that is vented to the atmosphere. During the operation of the conveyor a considerable amount of vapor and dust is dicharged from the vent. As the plant is in a residential section of the city, the dust causes considerable annoyance and the company has been threatened with damage claims.

We have tried water sprays in the vent, and this stopped the dust to some extent, but it will not be possible to use the sprays during the winter months, as the water will cause the ashes to freeze in the bunker. Can some reader of *Power* suggest some effective way of eliminating the dust nuisance? W. B. TROTT.

Minneapolis, Minn.

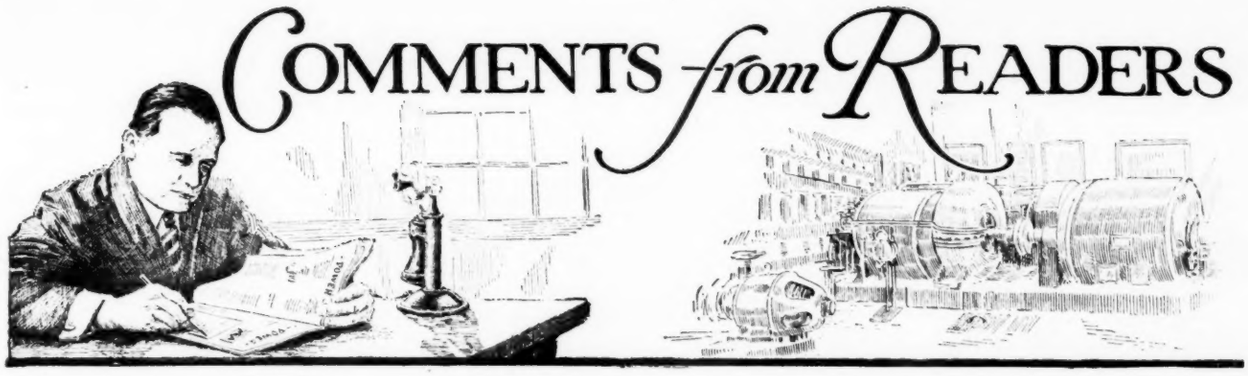
Futility of Memorizing Data

Many young men, when beginning the study of engineering, have a liking for learning and memorizing all the details of construction and operation of as many mechanical devices as possible, not only of the machines they are operating, but of miscellaneous machines that they may never have to operate. In my opinion this is not the proper course for a young engineer to follow. He should dig only for the essentials and not attempt to memorize anything that notes will cover. From the beginning of his career as an engineer he should have a data book available in which he can make notes and paste cuts of the different types of equipment with which he comes in contact and also new equipment that appears from time to time. Cuts and notes of the different apparatus are always available from advertisements or catalogs.

The principle involved in the design of power-plant equipment is in a general way much the same. Take, for instance, ten steam traps of different makes. While they may differ in details of construction, the principle of operation is practically the same, and if one thoroughly understands the operation of any one trap, he will readily understand the others and likewise with any other type of equipment.

Speaking from personal experience, I have found a data book, such as mentioned, to be valuable help and it has saved me hours of study. I have now compiled references and cuts relative to more than one thousand power-plant devices, and it enables me to keep conversant with the latest developments in power-plant equipment. A. D. PALMER.

Fall River, Mass.



Steam-Cylinder Clearance of Direct-Acting Pumps

As a designer of hydraulic machinery I would like to add to the answer given to the question asked by C. W. T. in the Sept. 19 issue, as there are several other factors of even greater importance which make it necessary to have greater clearances in pump cylinders than in engine cylinders.

If it were only a matter of not striking the cylinder heads, a steam cushion port with regulating valves would permit much smaller clearances than are commonly used, and thus effect a great saving in steam, but there is the point. A direct-acting pump is not used where high steam economy is desired. It is used for positive action and simplicity of operation and upkeep, and it is through the use of this apparently excessive clearance that positive action is brought about. If it were necessary to have the piston stop at, say, $\frac{1}{16}$ in. from the cylinder head, it would require a more accurate and sensitive valve mechanism than any I have yet seen. By having the clearance an inch or more, the valve mechanism is given a chance to take up all lost motion and strains, and still trip before the absolute limit of the stroke.

Another reason for large clearance in the steam cylinder of a direct-acting pump is the additional expense that would be involved in manufacturing pumps with smaller clearance. This would have to be added into the cost of the pump. Of course the economy of the pump would be increased by closer machine work and smaller clearances, but as already mentioned, the direct-acting pump is not suitable where economy is the primary object.

R. K. ANNIS.
Columbus, Ohio.

Filing Information

I read with a great deal of interest the foreword in the June 27 issue on "Filing Information." The manner of indexing you describe is one which I think every business man would use, once he had heard of or seen the index cards for vertical filing.

The alphabetical arrangement of the cards considering the subjects, however, quickly grows cumbersome and looking up a reference is made a long searching business by the fact that under one letter may be collected very different matters, such as "T: Turbines, Tram cars, Tension tests," etc.

Alphabetical filing should be reserved mainly to the filing of authors' names, when such filing seems interesting and useful for classifying standard books. Systematical filing, on the other hand, should be applied in every case where reference to the subject is leading, and for this purpose, which is the one you refer to, there exists none better than the thoroughly American "Decimal Index," by Melvil Dewey.

I need not point out the wonderful work that has been incorporated in this best of all indexing catalogs. About five years ago I introduced this system of filing in our firm, which is one of the main electrical concerns of Europe, and it has proved a real success.

We not only file all the technical data of some 120 technical periodicals of all countries and languages, but we also publish short references regularly in our house journal, the *Brown-Boveri Review*. These references are printed on one side of the page only, the other is left blank, and the items are strictly arranged after the Dewey decimal classification, a system which in my opinion is the last word on filing.

ERNEST R. BARLOCHER,
Chief Librarian of the Augarten Library.
Baden, Switzerland.

Insulating Furnace Walls

I have read with interest Mr. Matthew's comments on my remarks on insulating bricks in *Power* for Sept. 12, but think that, while true in a literal sense, they evade the main question of how and to what extent to use insulating brick in furnace-wall construction.

Such bricks are comparatively expensive, so the purchaser should be asked to pay the increased price only if the resulting boiler setting will give correspondingly more economical results. It is of no particular interest to the plant owner that by reducing the conductivity of his furnace walls the radiation loss is decreased 3 per cent if his setting soon cracks and the resulting air leakage increases the flue loss 5 per cent.

For the same reason it is the total conductivity from the flue gas inside the setting to the air outside, rather than a theoretical conductivity in the brick, that is commercially important. As the surface resistances are large and will be the same in both cases, since both have firebrick in contact with the furnace gases and red brick in contact with the air, the addition of the same actual amount of resistance to heat flow will increase the lower resistance proportionally much more than the higher resistance.

The figures Mr. Matthew gives for the strength of the insulating brick show that they are in the same class mechanically as a poor grade of salmon brick and would work about the same as bonds in a wall. The photograph shown as Fig. 4 is by no means conclusive of the advantages of using the insulating brick to bond with firebrick, as the only thing it shows is that the bricks are the same size. Judging from the unsmoked

appearance of the brickwork around the ports, it had never seen a fire to test it.

Referring to Mr. Matthew's final paragraph, one of the advantages claimed for the insulation of boiler settings in his original article (next to last paragraph) was "freedom from leaky settings," and it was to this, in connection with the types of wall construction shown, that the writer took exception. H. D. FISHER.

Swarthmore, Pa.

Boiler-Plant Efficiency in England

I was much interested in the statement of results of a large number of boiler tests made in England, given on page 146 of the July 25 issue. I conclude that the boilers on which these tests were made were all of the Lancashire type, and this is probable, as that is the favorite type in England. The results were poor, as might be expected, especially if the boilers were forced. The percentage is given of the number of boilers in England that are equipped with economizers, and comment is made upon the larger percentage of English boilers so equipped than American.

RESULTS OF TESTS MADE ON LANCASHIRE AND CORNISH BOILERS

	1	2	3	4	5
Location	London	London	London	London	London
Type of boiler	Lancashire with gal. tubes (same boiler)	Lancashire with gal. tubes	Lancashire gal. tubes with economizer	Cornish gal. tubes	Cornish with gal. tubes
Date	July 20, 1888	Jan. 14, 1887	Mar. 18, 1887	June 20, 1888	Mar. 16, 1887
Number of boilers tested	One	One	One	One	Three
Grate area total, sq.ft.	15	15	21	16.75	63
Heating surface total, sq.ft.	582	582	936 boiler 2,078 economizer	324	2,100
Duration of tests, hr.	12	9	9.1	8.00	10
Average steam pressure, lb.	57	50	77.8	51.6	37
Temperature of feed water, deg. F.	71	48.6	86.8	91.1	116.2
Water used per hour, lb.	2,369	1,277	3,760	2,104	4,401
Coal fired per hour, lb.	278	169	352	262.5	432
Moisture in coal, per cent	4.2	5.5	2.35	1.09	0.35
Dry coal used per hour, lb.	266	160	344	260	430
Dry ash and refuse per hour, lb.	10.6	10.8	7.4	17.9	40
Combustible used per hour, lb.	255	149	366.6	242.1	390
Gas temperature at chimney base, deg. F.	630	334	278	533	485
Gas temperature before economizer, deg. F.	No economizer	No economizer	401	No economizer	No economizer
Draft at chimney base, in.	0.4	0.35	0.60	0.62	0.47
Water evaporated per lb. dry coal, lb.	8.9	7.98	10.93	8.09	10.24
Equivalent from and at 212 deg., lb.	10.46	9.54	11.42	9.25	11.47
Evaporation per lb. combustible, lb.	9.28	8.57	11.17	8.69	11.28
Equivalent evaporation per lb. combustible, lb.	10.90	10.24	11.67	9.94	12.63
Efficiency, per cent	67.6	70.4	71.3 boiler 9.7 economizer	61.8	78.30
Dry coal per sq.ft. grate per hr., lb.	17.73	10.7	16.4	15.5	6.83
Equiv. evaporati n per sq.ft. heating surface per hr., lb.	4.61	2.62	4.20	7.42	2.35

Persons who are not familiar with English boiler practice may not know that economizers were invented in England for the purpose of rendering the Lancashire and Cornish boilers there used somewhat economical. These boilers are large and expensive, take up a great deal of room, and when of the largest usual size have only about 1,000 sq.ft. of heating surface and about 30 to 36 sq.ft. of grate area. Much of this surface is composed of the parts of the shell that are swept by the gases after they leave the furnaces. These side and bottom passages are far from airtight and cannot be made so permanently. They have but little effect and tend to decrease the draft. Some Lancashire boilers have transverse Galloway tubes in the furnaces, but they accomplish little or nothing as they have only a few square feet of heating surface. They assist the circulation when firing up and tend to prevent leaks on the bottom of the boiler.

This type of boiler violates an important principle of heat absorption, namely, division of gases into fine streams, such as takes place in any form of multi-tubular boiler. Multi-tubular boilers of some kinds are made in England, and it is well known that it is the home of the locomotive and Scotch types and various kinds of "express" marine water-tube boilers.

While in England the economizer is the "saving clause" with Lancashire and Cornish boilers; in this country it is much less necessary because we use boilers of an economical type. There are, of course, many persons in England who fully understand what produces economy of fuel in boiler plants. English shipowners know that they must use economical boilers, and it is strange that there is on land in that country so little appreciation of the means of economy in steam production and so much of it at sea.

As examples of what boilers of the type in question will do, general results of several tests made by Bryan Donkin and Prof. A. B. W. Kennedy on several Lancashire and Cornish boilers are given in the table herewith.

The fuel used was picked Nixon's navigation coal from Wales. It was thoroughly mixed in order to make it uniform and was transported in bags to various parts of England and to the Continent for the purpose of having all tests made with the same coal. The greatest care was used in making the tests, and they were all made by the same men. Rehearsals were made before the reported tests were made. The heat value of the fuel was 15,560 B.t.u. per pound of dry combustible.

It will be observed that while the results are in general poor, those in column 5 are good, and this test shows how well the boilers will do when they are lightly worked. There are three boilers working in this test and they were located in the East London Water Works, Bow, London, there being four boilers in the station.

F. W. DEAN,
WHEELOCK, DEAN & BOGUE, Inc.,
Boston, Mass. Engineers.

Titles and Degrees

I have read G. E. Miles' article on "Would-Be Electrical Engineers," in the Sept. 26 issue of *Power*, and my interest in the subject has prompted this article. The first time a man starts a steam engine, whether he does it right or not or whether he knows anything about steam engineering or not, he becomes, in his own mind at least, a steam engineer. The first time a man installs an electric bell, starts a motor or wires a building for the use of electricity, whether he knows anything at all about electricity or not, he becomes, in his own mind, an electrician and so assumes the title. This same reasoning applies also to the other professions in which men assume titles whether they are qualified or not.

A steam engineer is defined as a person versed in the technics and practice of steam engineering. Since there

is no proper title which a man not so qualified may assume, he may be justified, somewhat, in taking the title of steam engineer even though it might not be quite fair (from the viewpoint of time, money and hard study) to the man who can really qualify as a steam engineer. The title thus becomes one that denotes an occupation irrespective of whether a man is simply a "starter and stopper" operator or is well versed in the art. Proper titles should be devised for those well versed in the art and also for those not so proficient, and all persons should be honest enough to assume the correct title until qualified for a higher one.

An electrician is defined as a person versed in electricity, technical as well as practical. At present it defines an occupation and is applied to all persons doing any kind of electrical work whether they know anything about the technics of the art or not. This application is common and is justified, since there are other qualifying titles such as chief electrician, master electrician and, finally, electrical engineer. These are progressive, and no person should assume any of them without the necessary qualifications.

There are multitudes of men of the type described by Mr. Miles who assume the title "E.E." It is needless to say that this is wrong and exceedingly unfair to those who labor and study hard and spend many years in college in order to get the degree. It is also unfair to the colleges conferring such degrees as well as to the professors who labor hard with the students. It is not necessary for a man to go to college, in these days, because of the many excellent and thorough books available, but he should go if possible. In the early days it was almost necessary to go to college to get an engineering training. The advent of the various correspondence schools and other high-class engineering schools has changed things wonderfully, so that if a man will only study he will "get there." I do not wish to convey the idea that it is necessary to be a college man to be successful, since such a person must combine theory with practice as much as a person should who has never been to college. I write this from the viewpoint of one "on the second rung of the ladder" in the electrical art and with a view of securing justice for the genuine electrical engineer.

HENRY MULFORD.

Patchogue, N. Y.

Don'ts for the Boiler Room

I was much interested in the boiler-room instructions and twelve "Don'ts" for firemen on page 351 of the Sept. 5 issue. There has been much published in the way of instructions for the boiler room, but these usually pertain more to the general operation of the plant than to the safe operation of the boiler.

The Hartford Steam Boiler Inspection and Insurance Co., of Hartford, Conn., has prepared a number of "Don'ts" that are adapted to the needs of the average fireman; they read as follows:

A DOZEN DON'TS FOR THE BOILER ROOM

1. Don't fail to blow down water column and gage glass on each boiler when going on duty and several times while on duty, nor fail to try the gage cocks frequently to be sure the level of the water in the gage glass is correct.
2. Don't neglect to test all safety valves each day to be sure they are not stuck. Test-levers placed on pop valves are for this purpose, and they should be kept in place.
3. Don't fail to report any leakage or unusual conditions to someone in authority and request that he advise the insurance inspector.
4. Don't connect a boiler to the steam main until the pressure in the boiler is the same or not more than three pounds above the pressure in the main.
5. Don't forget that a badly scaled boiler is unsafe and will make your work harder in keeping up steam pressure and that the least amount of oil in a boiler may become a source of danger.
6. Don't attempt to make repairs to a boiler or steam piping while under pressure. Take them out of service for such work, and if the boiler is out of use for more than a few days do not fail to drain and thoroughly dry it out.
7. Don't be careless when you blow down a boiler. Be sure that the water discharged can do no damage to any person. Open and close the blowoff valves slowly and stay on the job from start to finish.
8. Don't neglect the pressure gage or fail to have it tested. Some time it may be wrong.
9. Don't pull your fire if you get low water. Cover it with wet ashes or a heavy layer of coal, close the ashpit door and the damper and open the furnace door. Keep the engine or other steam-using apparatus operating until the pressure goes down. Do not feed any water to the boiler until the pressure is below 25 pounds and you have satisfied yourself that no damage has been done by overheating.
10. Don't try to raise steam in a cold boiler too quickly. You may ruin it.
11. Don't close up a boiler after cleaning before you are sure that all tools, waste, etc., are removed from it.
12. Don't depend on others to see that everything is all right. See to it yourself.

Hartford, Conn. W. D. HALSEY.

Comparison of Synchronous Motor-Generators and Rotary Converters

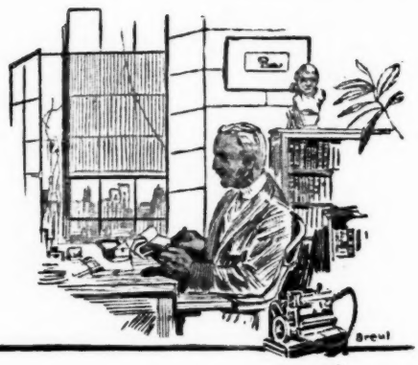
In the issue of Sept. 12, on page 411 there appeared a short article on the comparison of synchronous motor-generators and rotary converters. From reading this article, one not familiar with the subject would gain the impression that the synchronous motor requires an extra exciter, either direct connected or belted.

The writer wishes to take exception to this, as the synchronous-motor fields, if properly designed, can be operated from the direct-current end of the motor generator set, whether this generator is supplying direct current at 125, 250 or 550 volts, and whether its voltage is controlled by hand regulation or by a Tirrill regulator. We know, from actual installations which we have made and which have been running for a number of years, that a synchronous motor-generator set does not require a direct connected exciter or a belted exciter to excite the fields of the motor.

Chicago, Ill. J. R. WATSON,
Electric Machinery Mfg. Co.

In a recent paper discussing the production of fuel oil from coal, the British Fuel Research Board made the following mention of new developments said to be taking place in Germany: "The work of Dr. Bergius, in Germany, on the hydrogenation of heavy oils and tars, and even on bituminous coal itself, has opened up new possibilities in the production of liquid fuels from coal. It is claimed that in this way the yield of gasoline, Diesel oil, and fuel oil, from coal, can be enormously increased. If these claims can be substantiated, the consequences will be of far-reaching importance. The Fuel Research Board has, therefore, been in close touch with Dr. Bergius and his colleagues for the past year, and hopes ere long to be in a position to study the process and its possibilities at first hand."

QUESTIONS AND ANSWERS



Stock Required for Forming Rivet Heads

What lengths of shanks are usually allowed for boiler rivets for forming the heads? F. M.

The approximate proportions of rivet heads usually employed for boiler rivets and the volume and length of the shanks required for forming the heads for joining plates of given total thickness are indicated in the sketch. The cone head is the usual one pressed on the

	CONE	STEEPLE	PRESSURE
Volume of one Head in Terms of undriven Shank Diam.	$1.279\,d^3$	$1.178\,d^3$	$1.080\,d^3$
Length of Shank, in. to join Plates of Total thickness=t"	$t+\frac{0.125\,t}{d}+1.63d$	$t+\frac{0.125\,t}{d}+1.50d$	$t+\frac{0.125\,t}{d}+1.38d$

HEADS AND SHANK-LENGTHS FOR BOILER RIVETS

rivets as furnished by manufacturers. The steeple head is the one usually formed in hand riveting, and the pressure head is the form most commonly obtained in machine riveting.

The sketch shows the approximate dimensions of heads and volumes of the heads in terms of undriven shank diameter d; also length of rivet shank for joining plates of total thickness t in terms of d and t, with allowance for stock required to fill the clearance $\frac{1}{32}$ in. around the rivet and for forming the heads of the different kinds illustrated.

Generator Trouble from Lightning

We have two alternating-current generators, one driven direct from a waterwheel and the other belted to an engine. Since a recent lightning storm both generators make a humming noise. In other respects they seem to be running all right, except that the amperage is 10 to 15 per cent too high. How can we locate and remedy the trouble? N. H. H.

The trouble probably is due to a ground in the winding of each generator. Disconnect one generator from the busbars by opening the line switch. Bring the voltage up to 550 v. Test between ground and each generator lead with a lamp. If the lamp glows at any lead, it shows a ground. This should be a 550-volt lamp if possible. If a 550-volt lamp is not available, try two 220 lamps in series. Try this also on the other generators. If a ground is present, which is most likely, the winding will have to be cut into sections and each section tested out until you locate the exact coil or coils that are grounded. A magneto is required for this sort of testing, unless one side of the other generator can be grounded through a fuse wire and a non-grounded phase used as a source of current. The lamp is to be connected between this source and the part of the winding tested. It would undoubtedly pay to have a good armature winder do this work.

If only one or two coils are grounded, it is often possible to cut these out of service and operate until there is a good chance to repair them. If no ground is found, look for short-circuited coils, which will cause hot spots in the winding.

Boiler Output with Double Rate of Feeding

A boiler connected with others on the same header in which the pressure carried is 125 lb. gage furnished 4,000 lb. of steam per hour, generated from feed water at 180 deg. F. that is supplied at the rate of the evaporation. How many pounds of steam at the same pressure would be delivered by the boiler per hour when supplied with the same amount of heat and same temperature of feed water, if the rate of feeding is doubled? A. L.C.

When the rate of feeding is the same as the rate of evaporation, each pound of the feed water would receive the amount of heat necessary to raise it to the temperature of evaporation plus the latent heat required for evaporation. But when twice as much feed water is to be raised to the temperature of evaporation, less of the heat furnished by the boiler would be available for completing the evaporation.

For generation of steam at 125 gage, or 140 lb. per sq.in. absolute, the heat of the liquid at the temperature of evaporation must contain 324.6 B.t.u. above 32 deg. F., and each pound of steam generated must receive 867.6 B.t.u. as latent heat of evaporation.

Hence, to raise a pound of feed water from the temperature of 180 deg. F., or 180 — 32 = 148 B.t.u. above 32, to the heat of the liquid would require 324.6 — 148 = 176.6 B.t.u., and the heat received for its evaporation into steam would be 176.6 + 867.6 = 1,044.2 B.t.u.; hence the total heat received per hour from the boiler would be 1,044.2 × 4,000 = 4,176,800 B.t.u. But if 2 × 4,000 = 8,000 lb. of feed water must be raised to the heat of the liquid requiring 176.6 × 8,000 = 1,412,800 B.t.u., then there would remain only 4,176,800 — 1,412,800 = 2,764,000 B.t.u. available for the latent heat evaporation, and as the latent heat required per pound of evaporation at the stated pressure is 867.6 B.t.u., the output by the boiler while the rate of feeding is doubled would be at the rate of 2,764,000 ÷ 867.6 = 3,185.8 lb. of steam per hour.

Sludging of Turbine Oil

We have a small non-condensing turbine operated at 100 lb. gage against 4 lb. back pressure and have great trouble with oil sludging in summer, when our station load is heaviest, using the best oils obtainable. What would you advise as to the cause of our trouble?

H. F.

Probably the bearings are overheated on account of the high back pressure of the exhaust, which has a tendency to heat the shaft. If the engine room is excessively hot in summer, as must be the case, the trouble may be due to overheating of the oil. If the temperature of the oil reservoir exceeds 180 deg. F., we suggest that you water-cool the oil during the hot season. Place a jointless coil in the reservoir of the turbine, or pipe the pressure line through a tight cooler. Make sure that no water, or at least very little, enters the oil system. If the shaft packing leaks badly, a great deal of water may be condensed inside the bearing housing.

Poppet Valves

What are the advantages of poppet valves, and why are they not used more generally for steam engines?

S. B. M.

The advantages of poppet valves are that when made in the form of double-seat, or as commonly termed, "double-beat" valves, they may be nearly balanced by the steam pressure and may be operated to obtain quick and large opening and quick closing.

The principal double-seat types of poppet valves are illustrated in Figs. 1 and 2 with the valves open for flow of steam in directions indicated by the arrows. It is to be noted that in the form shown in Fig. 1 the flow takes place downward toward the upper seat *U* and upward toward the lower seat *L*; while in the type illustrated in Fig. 2 the flow toward the lower seat *L* is

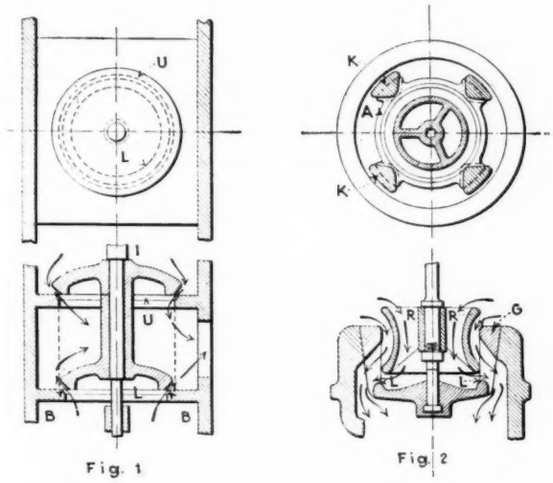


Fig. 1 Fig. 2

TYPES OF DOUBLE-SEAT POPPET VALVES

received axially through the upper part of the valve in the direction indicated by the arrows *RR* and thence the discharge is radially outward from the center. In many cases the inside diameter of the upper valve seat is enough larger than the lower seat *L* to permit admission of the lower portion of the valve through the upper valve seat when the parts are assembled. The unbalanced effect due to the difference of diameters of the upper and lower "disks" required in the constructions illustrated in Figs. 1 and 2 sometimes is overcome by making the upper and lower disks of the same diameter and providing a ring seat fastened to the valve chamber to form a seat and fill the opening required for admission of the lower disk. In Fig. 2 the valve seats are in an open cage *G* with the lower seat *L* suspended by hangers *KK* shown in the plan view.

The disadvantages of the double-seat valves are cost of construction and application and leakage from un-

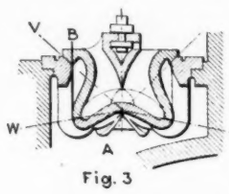


Fig. 3

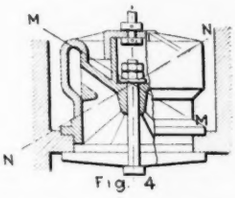


Fig. 4

TYPES OF DOUBLE-SEAT POPPET VALVES WITH SEATS FOR COMPENSATION OF WARPING AND UNEQUAL EXPANSION

equal expansion or warping of the disks and seats when heated by the steam. There are various modifications of design for overcoming such distortions, usually by providing the seat surfaces of conical form with a common apex in the valve center line. Fig. 4 is a part section view of such a valve where the separate seating surfaces are on lines *MM* and *NN* intersecting in the valve center line between the upper and lower seats.

In another form, shown in sectional view, Fig. 3, the surfaces of both seats are different conical surfaces with sides *V* and *W* and apexes of the cones meeting at *A* in the valve center line.

Appearance of Perfect and Imperfect Combustion

How can the character of combustion of furnace gases be recognized from their appearance? A. N.

When there is complete combustion, the gases, while still presenting an irregular flaming appearance, are nearly transparent. When the air supply is insufficient, the combustion chamber is filled with opaque gas or smoke.

The character of the combustion may be recognized by observing the gases through a violet blue glass. When perfect combustion is viewed through such a glass, the interior of the furnace and fuel present a lavender gray color, and flames of imperfect combustion present the appearance of dark-colored gas.

Increase of Stack Capacity for Greater Height

Our brick stack has a 36x36-in. flue and is 80 ft. high. What per cent would the capacity be increased by making the stack 25 ft. higher? W. L. B.

For the same temperature of flue gases the draft pressure would be directly as the height, but the velocity of the gases would be as the square root of the pressure and the chimney capacity for different heights would be as the square roots of the heights; namely, as $\sqrt{80}$ to $\sqrt{80 + 25}$, or as 8.944 to 10.247.

Hence the capacity would be increased $(10.247 - 8.944 \times 100) \div 8.944 = 14.6$ per cent.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Flywheel Explosions and Their Prevention*

By E. B. TOLSTED

STATE and city regulations practically disregard flywheels. It must be only a question of time when regulations and laws will protect lives and property against flywheel accidents as they now protect them against other hazards.

It should be remembered, that a split cast-iron pulley or a flywheel with a flanged joint carrying a belt that runs at 5,000 ft. per min. is going altogether too fast. A solid cast-iron pulley can run at about 6,100 ft. per min. and still have a factor of safety of 10, which is the figure that should be used in pulley and flywheel work.

The solid wheel can be used only if the diameter is less than 10 ft., on account of the difficulties in construction and shipment. The link-jointed wheel can be conveniently adopted only where the rim is thick, and since such a rim is not frequently used for belt or rope driving, a solid or a flange-jointed wheel is used.

The following shows the products of the revolutions per minute and the diameter which should not be exceeded if it is desired to keep the factors of safety at 10 or above, maximum stress figured at 10,000 lb. per sq.in.:

a. For solid cast-iron flywheels the product of the revolutions per minute and the diameter (in feet) should not exceed 1,937.

b. For link-jointed cast-iron flywheels the product of the revolutions per minute and the diameter (in feet) should not exceed 1,500.

c. For flange-jointed cast-iron flywheels the product of the revolutions per minute and the diameter (in feet) should not exceed 968.

The diameter referred to is not to be taken as the outside diameter of the wheel, but as the mean diameter of the rim.

Since the stress increases with the square of the speed, it follows that the wheels can operate, not 10 times as fast but $\sqrt{10}$ times as fast as is indicated by the figures given, before they will actually burst. The $\sqrt{10}$ is approximately 3.16, therefore the highest speeds that wheels are likely to be able to attain, expressed in terms of product of speed and diameter, are: (a) Solid wheels, 6,120; (b) Link-jointed wheels, 4,740; (c) Flange-jointed wheels, 3,059.

Formulas for Finding Factors of Safety

In order that you may know the approximate factors of safety of your wheels, the following formulas may be applied:

For a solid wheel the factor of safety equals $\frac{(1{,}937)^2 \times 10}{(RD)^2}$

For a link-jointed wheel the factor of safety equals $\frac{(1{,}500)^2 \times 10}{(RD)^2}$.

For a flange-jointed wheel the factor of safety equals $\frac{(968)^2 \times 10}{(RD)^2}$.

As already explained, the figures given are those for wheels with the best possible design of joint.

Therefore, if you make a computation from any of the formulas used above, you may be sure that your wheel is not better than the result obtained from an application of the formula, but that it is less good if the design is not of the best.

This assumption is to the effect that the flywheel is a ring revolving in space. In other words, it assumes that the spokes do not tend to hold the wheel together. While there are undoubtedly wheels that are partially held in place by the spokes, there have been enough cases proved of actual compression against the spokes to justify those who calculate wheels in considering that the spokes at least do not help to hold the rim together.

If the engineer could watch the erection of the flywheel and could make a record of the conditions existing as it goes into place, much that is later questioned could be answered. I have in mind a corporation in Chicago which erected a power house and put in a number of reciprocating engines. Link-jointed flywheels were used since the engines were direct-connected to generators and since belts and ropes were unnecessary. When the last link was cooling down after it had been shrunk in place, it broke. This made the company that had bought the wheels suspicious, and they drilled a small hole in each of the other links. Although the link was several inches wide and the hole was probably only ¼ in. in diameter, the removal of this small amount of material was of sufficient importance so that several other of the links broke. The reason for the breakage was that the links had been made too short in the first place.

Causes of Flywheel Accidents

While the principal cause of flywheel accidents comes from overspeeding, which may be normal or momentary, there are many contributing causes and several independent ones. The principal divisions are overspeeding, overloading and failures due mainly to defects, flaws and improper handling. The causes of overspeeding may be divided and subdivided as follows:

a. Normally high speed not necessarily exceeded when wheel breaks.

(Failure due to this cause is frequently in combination with a, b or c under the next heading.)

b. Breaking of engine parts.
c. Breaking of engine belt.
d. Engine belt running off flywheel.
e. Breaking of governor belt.
f. Slipping of governor belt.
g. Governor belt running off pulley.
h. Derangement of governor, which may be subdivided as follows:

(1) Struck by flying parts; (2) failure of governor pulley; (3) loose or lost setscrew; (4) loose or lost key; (5) gear or gears broken; (6) flyball off; (7) parts broken or sheared off; (8) insufficient lubrication.

i. Derangement of governor valve gear.
j. Loss of load. (Frequently when an engine speeds slightly, the first act on the part of man operating machines is to throw off these machines. This increases the likelihood of the engine speeding.)
k. Circuit breaker blown out, burning out of armature, or electrical load otherwise dropped.
l. Improper adjustment of engine stop, governor or valve gear, or governor or valve gear parts blocked or otherwise made inoperative, or engine stop out of commission.

Overloading may be divided as follows:

a. Clogging of machinery in mill.
b. Unusual number of machines forced at same time.
c. Careless or ignorant handling of friction clutches.
d. Short circuit of driven electrical machinery.
e. Sudden stoppage of engine.

Some of the miscellaneous causes of flywheel accidents may be divided as follows:

a. Failure of wheel due to flaw.
b. Failure of wheel due to improper material. (For instance, too high a percentage of phosphorus in a wheel is likely to make it brittle. Jobbing foundries frequently use phosphorus for small molds, which must flow readily. The effect of phosphorus in iron is to make it flow at a lower temperature than if the phosphorus were not present.)
c. Failure of wheel due to crystallization.
d. Failure of wheel due to internal stresses.
e. Failure due to accidents to engine.
f. Failure of wheel due to improper design.
g. Failure due to dirt or foreign materials carried in rim

*From a paper before the National Safety Council.

h. Failure due to holes drilled in rim.
i. Failure due to increasing diameter by adding on to rim.
j. Tight keys.
k. Wheel sttruck by flying objects.
l. Belt pull.
m. Loose bearings.

Of the foregoing causes derangement of the governor is probably the principal one and broken belts the next most important one.

Remedies for Dangerous Conditions

Generally speaking, remedies that can be applied for the prevention of flywheel accidents may be found among the following:

a. Better governors: (1) triple rope drive instead of single belt drive for governor; (2) governor sheaves to be keyed, and the unused portions of keyways to be filled in; (3) governor sheaves to have suitable guards of substantial construction; (4) safety cams on all Corliss valve gears; (5) guards around governors; (6) governor gearing inclosed in oiltight covers, readily detachable for inspection; (7) couplings, setscrews, keys, bolts, etc., in moving parts countersunk; (8) better care of governors.

b. Better care of engine parts, belts, etc.

c. Lower flywheel speed. (Two small wheels instead of one large one.)

d. Solid wheels instead of jointed wheels, or link-jointed wheels instead of flange-jointed ones.

e. Steel, wood or other wheels adapted to high speeds instead of cast-iron wheels.

f. Better design of equipment: (1) Avoidance of overload; (2) arrangement of steam piping to avoid breakage; (3) avoidance of materials fastened on outside of pulleys or flywheels and avoidance of holes drilled in such pulleys or flywheels; (4) locate engines and equipment so that the least possible damage will be done in case of breakage; (5) space in flywheel pits for broken belts; (6) signals from engine room to machine room and vice versa; (7) engine stops; (8) automatic valves on boilers; (9) bracing of dangerous wheels with tie rods; (10) frequent operation and testing.

The Better Types of Wheels

The accompanying table, which is made up for 10-ft. cast-iron wheels, shows the relative balancing effect of wheels at various speeds and the factors of safety of two types of wheels, the increase of speed necessary to break the wheel, and relative elapsed times necessary to reach breaking speed. It should be understood that the balancing effect and the times necessary to reach breaking speed are relative figures only.

TEN-FOOT DIAMETER CAST-IRON WHEELS

	Flange-Jointed Wheel				Solid Wheel		
Revolutions per Minute	Effect Balancing	Factor of Safety	Increase of Speed Necessary to Break	Time to Reach Breaking Speed	Factor of Safety	Increase of Speed Necessary to Break	Time to Reach Breaking Speed
96.87	1	10.00	2.16	1	40.00	5.32	4.32
150.00	2.41	4.16	1.04	0.84	16.62	3.08	4.18
193.74	4.00	2.50	0.58	0.67	10.00	2.16	4.00
306.00	10.01	1.00	0.00	0.00	4.00	1.00	3.33
612.00	40.00	.....	....	....	1.00	0.00	0.00

Referring to the table, the advantage of the solid wheel over the flange-jointed wheel is readily understood. Take, for instance, the third line of the table. This assumes a 10-ft. wheel to be operated at approximately 194 revolutions per minute. The balancing effect of two wheels is naturally the same. The factor of safety of the solid wheel is four times as great as that of the flange-jointed wheel. It must be increased in speed another 216 per cent before it breaks, whereas the flange-jointed wheel need be increased only 58 per cent. While this increase is going on, the engineer has six times as long to get the engine stopped as he would have with the flange-jointed wheel. If, for instance, the time with the flange-jointed wheel should be 10 seconds, he would have a full minute to stop an engine carrying a solid wheel. Few engineers could be expected to get the steam shut off their engines in 10 seconds. Most of them could do it in a minute if they had the nerve to make the attempt.

Wooden wheels may run faster than cast-iron wheels provided they are properly made. A well-made wooden wheel may be run about 50 per cent faster than the best cast-iron solid wheel and a well-made built-up steel wheel may be run about 88 per cent faster than a solid cast-iron wheel. Usually, however, cast-iron wheels, because of their lower cost, are adopted.

Greater Centralization for Federal Power Plants

Enlargement of the United States Capitol power plant at Washington so as to furnish heat, light and power to the Government Printing Office and the Botanic Garden, in addition to the buildings now served, is expected to effect economies of operation amounting to more than $100,000 a year.

Coincident with the abandonment of its independent steam plant, the Government Printing Office is installing an electric sub-station with transformers capable of taking care of much more than the immediate power needs of the plant, in anticipation of steady increases in electrical equipment. The Washington City Post Office, which has hitherto received heat, light and power from the Government Printing Office, also will be linked to the Capitol power plant when the change is made. Contracts for all the work and equipment, with the exception of the transformers to be installed at the printing plant, have been awarded, and work is in progress on the tunnels which will carry the steam pipes and transmission lines.

Although the Capitol power plant will take on a heavily increased load by the changes, it is estimated that an actual saving of coal will be effected by the installation of the new boilers. The buildings added to the plant will be charged with the service rendered, as they are controlled by different departments of the government, the steam being metered.

The Capitol power plant already serves the Capitol building, Library of Congress, the House and Senate office buildings and the small building occupied by the Coast and Geodetic Survey. A 400-yard leg of the tunnel will be run to the Botanic Garden, which has been using an antiquated independent steam plant. The change there is calculated to save $20,000 annually.

There will be installed in the Capitol power plant sixteen 5,710-sq.ft. Babcock & Wilcox boilers, with soot blowers and stokers, at a total installed cost of $239,840. They will replace a similar number of Atlas boilers of 500-hp. capacity which have been in service 13 years. These are being cut out in sections and scrapped. The same foundations will be used for the new boilers, and much of the auxiliary machinery will be retained. The new boilers will be set in batteries of two each, and the maximum number in operation will not be more than nine, in extremely cold weather. A saving of more than $14,000 a year in coal consumption is anticipated, despite the increased load, while further economy due to cleaner flues, those in the new boilers being spaced 7 inches, is expected to amount to around $11,000 annually, both estimates being based on the operation of eight boilers.

The Government Printing Office will dismantle and junk its steam plant when the change is completed. This plant has six 3,000-sq.ft. Scotch marine-type boilers and two 5,000-sq.ft. B. & W. boilers. The plant consumed last year for heat, power generation and industrial purposes about 14,000 tons of coal. The change is estimated to save $30,000 in expense annually, besides increasing efficiency and in addition saving about one million gallons of filtered water daily. The Capitol power plant draws its water directly from the Potomac River.

The printing plant will install an electric sub-station with rotary transformers of 4,500 kw. total capacity, divided between two or three units, this point remaining as yet undecided. The present power consumption of the print-

ing plant is between 1,400 and 1,500 kw. daily. Expansion to a maximum capacity of 4,500 kw. is necessary because of the early installation of fifty to sixty additional electric heating pots for typesetting machines, to replace gas, and the gradual installation of other electrical equipment. The Capitol power plant will not need additional generators, as it now has an equipment of four Westinghouse turbines of 2,000 kw. capacity, more than sufficient to take care of the enlarged load.

Foresee Use of Lignite as Domestic Fuel

Further information concerning the lignite experiments of the Bureau of Mines, at Grand Forks, N. D., mentioned briefly in *Power* for Sept. 26, shows that by charring lignite a fuel of great value may be obtained.

While the experiments were started with the view of developing lignite principally for industrial purposes, the results indicate wide possibilities for domestic use as a substitute for anthracite. A stove grate has been produced at Pittsburgh which will consume lignite char which has not been briquetted, and experiments are going forward to perfect boiler and kitchen-range grates for the same purpose.

The lignite is charred in special vertical kilns, between 40 and 45 per cent being obtained as char. The char has a heat content of between 11,000 and 12,000 B.t.u., and shows from 15 to 20 per cent ash. The pea sizes may be used without special preparation for transportation or feeding, and the dust may be briquetted, although briquetting has been found to be too expensive a process for most commercial purposes. The char may be produced and retailed at a cost considerably below the normal price of anthracite in the Dakotas. Charred lignite has none of the objectionable qualities of raw lignite, which is high in moisture, is liable to spontaneous combustion, and slags badly. No byproducts are obtained from the charring process.

The principal deposits of lignite are in the two Dakotas and in Texas, although there are other deposits in Arkansas, Oklahoma, Louisiana and California whose development might be profitable if there were a sufficiently great demand for the new fuel.

Water Power a Live Issue in New York State Campaign

Both the Republican and Democratic parties in New York State have held their political conventions, nominated their candidates and adopted their platforms. One of the principal issues in the coming campaign will be the development of the state's water-power resources.

While the Republican and Democratic platforms agree that any development of the surplus waters of the barge canal should be made by the state, since this canal has always been under state operation and control, there is a difference of opinion regarding the other potential water powers. The Democratic party is committed to the development of all water power by the state itself, while the Republicans advocate private development by license, under state supervision and regulation.

The Republican platform claims credit to the Miller administration for all that has been accomplished in the development of water power. It does not mention, however, the proposed amendment to the constitution of New York State, permitting the diversion, under state regulation and control, of only 2 per cent of the state-owned water power situated in the present forest preserve. This amendment, which must be passed by another state legislature before it can be voted on by the people, is bitterly assailed in the Democratic platform, in spite of the fact that the measure passed the legislature almost unanimously the first time and was at no time made a party issue by the Democrats.

The Republican convention, in making up its new state ticket, eliminated from the running Attorney-General Newton and Frank M. Williams, state engineer and surveyor, both of whom are said to be opposed to the administration's policy with regard to water-power development. Mr. Williams is said to have favored the St. Lawrence Canadian Government hydro-electric development scheme, which has been opposed by Governor Miller. Also he has been reticent in issuing certificates for the development of any power calling for the use of the surplus waters of the barge canal, on the ground that until the state shall complete its project at Crescent Dam and Visscher's Ferry, it is impossible to determine exactly what such surplus may be. In this attitude he is said to have had the concurrence of the attorney-general. The Republican nominee for state engineer and surveyor, Charles L. Cadle, of Rochester, present superintendent of public works in that city, is well in touch with electric and power interests, and it is expected that he will, if elected, co-operate actively in the Republican plans for water-power development.

Corrosion Research by Institute of Metals

The present confusion of theories in regard to the corrosion of metals is easily seen from the report of the Corrosion Research Committee made to the Institute of Metals at Swansea, England, on Sept. 20. Of the many theories regarding corrosion, the electrochemical theory has had the greatest number of supporters. Recent research seems to show that, while the electrochemical action is a large factor in most cases, it will not explain everything that happens. In other words, it seems that corrosion as ordinarily found is due to a combination of causes.

The paper defines corrosion as the oxidization of a substance. It points out that such oxidation may be produced by chemical or electrochemical means, the distinction being that chemical reactions are those that occur when the reacting bodies are in contact, while electrochemical reactions are those that occur when the reacting bodies are separated, with a third substance, called the electrolyte, between them.

To eliminate the electrochemical action, an extremely pure iron, free from strain, was prepared, and it was found that this could be corroded under certain conditions. It seems to be quite true, however, that ordinary commercial iron, with its impurities and strains, is corroded much more easily.

On the electrochemical theory the action of oxygen is that of a depolarizer. The paper states that atmospheric oxygen has very little depolarizing power at ordinary temperatures. The main function of the oxygen, according to this report, is to oxidize the metal directly, and also in some cases to oxidize the products of corrosion.

The new theories involve the action of what are called colloids. Although the complete explanation is highly technical and intelligible only to trained chemists, the following may help the engineer to get a rough idea of what is supposed to happen according to the colloid theory. A metal immersed in water sends positively charged metal ions into the liquid and becomes itself negatively charged. In the case of ordinary commercial metals the metal also becomes superficially oxidized if dissolved oxygen is present. The hydroxide produced by this oxidation can take up the ions given off by the metal, and the hydroxide thereby passes into the state of a positively charged colloid. Now the important thing to note is that this colloid can diffuse away, leaving the surface clean for further attack by the oxygen, so that the process can keep up continually.

For steady corrosion it seems that the colloid must be produced under conditions that allow it to diffuse some distance from the metal before it precipitates. If it precipitates directly on the corroded surface, it will, in general, adhere to the latter and stop corrosion. Something like this seems to happen in the case of corrosion pits, where the precipitation occurs on the rim of the pit, keeping that point free from corrosion and making the corrosion in the pit appear all the greater by contrast.

The chief conclusion that the engineer can draw from this report is that the chemical experts are still feeling around in their attempt to explain corrosion and that still other theories or modifications of the present theories may be expected as the research work continues. This work is found to bring results of practical value.

News in the Field of Power

Fuel Distributor's Field Forces Are Established

Fifteen Naval officers have been appointed field representatives of the Federal Fuel Distributor, and have taken up their duties in the territory east of the Mississippi River, which has been divided into fifteen districts for administrative purposes connected with coal distribution.

These officers have been instructed to keep Federal Fuel Distributor C. E. Spens informed daily regarding production and distribution of coal and the prices obtained in their respective districts. They are expected to watch closely for acute fuel shortages, to keep posted as to markets to which coal is moving, to note carefully the transportation conditions prevailing and to inform themselves as to whether the prices obtained for fuel are justified.

Priority orders for the movement of coal are being employed only rarely. The Federal Fuel Distributor is asking the Interstate Commerce Commission to issue such orders only in cases of real distress.

Norfolk & Western Equips Eleven Boilers With Powdered Coal

The stoker-fired boiler plant of the Norfolk & Western Railroad Co., at Roanoke, Va., is the latest to be redesigned and equipped to burn pulverized coal exclusively.

The plant consists of six 2,000-sq.ft. B. & W. boilers, each of which will be equipped with one vertical burner, and five 4,000-sq.ft. B. & W. boilers, to be fired with three vertical burners apiece. Various grades of coal from the Pocahontas field are to be used, especially bone and refuse coal, varying in ash content from 20 to 38 per cent, with a heat value of 10,000 to 11,000 B.t.u. per pound.

The coal drying, pulverizing and screw feeding equipment will be of Fuller-Lehigh manufacture, installed by the Fuller Engineering Co., while a Fuller-Kinyon conveying system will transport the pulverized coal from the mills to the furnace bins.

Brooklyn Edison Starts Record Plant

Work has been started on the Brooklyn Edison Company's new 400,000-kw. steam-turbine station, whose site is on Hudson Avenue adjoining the Brooklyn Navy Yard and facing the East River. Two 62,500-kva. turbo-generator sets, the largest single-cylinder machines thus far built, will form the initial installation. Westinghouse will build one and General Electric the other, and each will be wound for 13,800-volt three-phase 60-cycle current. In spite of the record size of the first turbines it is expected that when the final installation is made there will have been advances in the art of steam-turbine design permitting the use of still larger units.

There will be eight Babcock & Wilcox stoker-fired boilers, each having 16,950 sq.ft. of heating surface. Six of the stokers will be made by Westinghouse, and two by the Combustion Engineering Corporation. The condensing equipment will be of Westinghouse manufacture. It is expected that the first section of the plant will be in operation by November, 1923.

The Coal Industry Should Watch Its Step

The feeling in official circles in Washington is that the coal industry, instead of showing hostility toward the newly created Federal Fuel-Distribution System and the Fact-Finding Commission, should accept this legislation in good grace and co-operate fully with each of the new governmental agencies. It is felt that the industry is getting off easily, after such a major disturbance as that of the recent strike.

If, on the other hand, after practically wiping out the nation's coal reserve and causing the public great inconvenience and possible hardship during the coming winter, the coal industry has the presumption to fight the new agencies of distribution and investigation with injunctions or test suits, it is held probable that the industry will bring down upon itself a form of regulation that soon would place it in the public-utility class. It is contended that the purpose of the recent legislation is legitimate, and that if by any chance Congress has exceeded its powers, the strength can be mustered to increase those powers sufficiently to meet the situation.

New Tallapoosa Development Applied For

The Alabama Power Company has applied to the Federal Power Commission for a preliminary permit covering the construction of four dams for the development of 60,000 primary horsepower on the Tallapoosa River in Elmore, Randolph, Chambers and Tallapoosa counties of Alabama.

The application follows the report of the chief of engineers to the effect that the project comes under the jurisdiction of the Federal Power Commission. It is understood that the company plans the full development of this project within ten years. It is the company's intention to go through with this development regardless of any rights that it may acquire at Muscle Shoals, and it is said that this work would not be delayed even were the company to acquire the Sheffield steam plant.

Management Week Will Be Observed from Coast to Coast

The week of Oct. 16-21 has been set apart for a series of meetings of A.S.M.E. local sections in all parts of the country, at which the problems of management will be discussed in an attempt to improve the operation of our complex industrial organization. A period of intense competition is conceded to be just ahead, and these meetings will, it is hoped, do much to prepare the engineering world for inevitable increases in production, with the consequent need for more efficient management.

Management Week is being sponsored by the Management Division of the A.S.M.E., in co-operation with the Society of Industrial Engineers and the Taylor Society. The main topic to be considered at all section meetings—"Standards for Measuring the Value of the Work of a Manager or Management"—opens the door wide for discussion of concrete examples in the locality of each section. The paper entitled, "Ten Years' Progress in Management," by L. P. Alford, editor of *Management Engineering* and vice-president of the A.S.M.E., will be read in several sections and will furnish a convenient starting point for discussion.

Commonwealth Edison To Build New Chicago Plant

On Oct. 3 the directors of the Commonwealth Edison Company, of Chicago, authorized the immediate enlargement of the company's Calumet station and the construction of a new plant on the West Side of Chicago.

Two 30,000-kw. units will comprise the third section of the Calumet station. The first section, of like size, was placed in service two years ago and the second soon will be completed. The new West Side plant will eventually contain eight 35,000-kw. units, two of which will form the initial installation.

Sheffield Plant Furnishes Power to Large Area

Electrical energy generated at the government steam plant at Sheffield, Ala., one of the Muscle Shoals plants, is now being relayed by intervening systems to aid industries in various communities of the southeastern United States, some of them 600 miles away, according to Thomas W. Martin, president of the Alabama Power Company.

"There is an unusual industrial demand for power in this section," says Mr. Martin. "This, coupled with the coal shortage, the inability to obtain prompt deliveries of coal and the low water at hydro-electric plants, has brought about a serious situation. The water-power plants and reserve steam plants in some parts of North and

South Carolina and Georgia have been unable to take care of the power requirements of cotton mills and other industries. Therefore, the Sheffield steam plant is now being operated to benefit the entire Southeast. Being nearer the coal mines than other plants, its operation is possible where other plants, remote from those fields, are having difficulty in obtaining fuel."

Obituary

Herbert C. Follinger, manager of the Chicago office of the Chain Belt Co., died of pneumonia at his home in Chicago on Sept. 27. Mr. Follinger was 38 years of age at the time of his death and was born at Fort Wayne, Indiana. In 1902 he graduated from the Chicago Manual Training School, now part of the University of Chicago, and entered the employ of the Otis Elevator Co. He became associated with the Chain Belt Co. in 1914, and in 1916 was appointed district manager for the Chicago territory.

Personals

R. C. Bailey has resigned as business manager of the American Association of Engineers and is now with the Federal Electric Co. as sales engineer of multiphase and renewable fuses in the Philadelphia district.

H. A. Pendergraph has succeeded W. P. Guinan as business manager of the Montgomery (Ala.) Light and Water Power Co. Mr. Pendergraph comes from Athens, Ga., where he has been for the last three years business manager and representative of H. L. Doherty Co.

O. P. Hood, chief mechanical engineer of the United States Bureau of Mines, will return to his office Oct. 16 after having spent three months in Europe on official business. Mr. Hood visited England, Ireland, France, Italy and Germany to study low-temperature carbonization, smoke abatement, the use of lignite and peat, and combustion problems in general.

Society Affairs

The following local sections of the **A.S.M.E.** will hold meetings at which management will be the chief topic of discussion, during or following Management Week:

Atlanta, Oct. 24. A dinner meeting at which the chief speaker will be Prof. W. W. McLaureine, of Georgia Tech. There will be discussion by Frank H. Neeley and Prof. J. F. Cannon.

Boston, Oct. 19. At Harvard University, Cambridge, Mass., at 2:30 p.m. and 8:00 p.m. The subject will be "Management as Related to the Business Cycle." The meetings will be held in conjunction with the Boston Chamber of Commerce, Associated Industries of Massachusetts, Taylor Society, Society of Industrial Engineers, Boston Association of Stock Exchange Firms, Massachusetts Bankers' Association, Harvard Graduate School of Business Administration and Harvard University Committee on Economic Research.

Bridgeport, Oct. 19. A dinner meeting at the Stratfield Hotel at 6:30 p.m.

Buffalo, Oct. 18. At the Iroquois Hotel at 8 p.m.

Central Penn., Oct. 16. Dean Dexter S. Kimball will speak.

Chicago, Oct. 18. An evening meeting at the Auditorium Hotel, to be held jointly with the Western Society of Engineers, the Taylor Society and the Society of Industrial Engineers. A second evening meeting will be held on Oct. 20 at the same place.

Cincinnati, Oct. 19. Dean Kimball will speak.

Cleveland, Oct. 17. A joint meeting with the Cleveland Engineering Society, Society of Industrial Engineers and Taylor Society.

Colorado, Oct. 27. At the Metropole Hotel at 6:30 p.m. The subject will be "Factory Management."

Columbus, Oct. 20. At the Southern Hotel, Engineers Club, at 8 p.m. The speakers will be John Younger, of Cleveland, and Dean Kimball.

Indianapolis, Oct. 18. At the Claypool Hotel, to be held jointly with the Indianapolis Chamber of Commerce, following a banquet in the Riley Room, at 6:30 p.m. Charles M. Schwab, President of the Bethlehem Steel Co., will speak.

Meriden Branch, Oct. 16. There will be a reading of the paper entitled "Ten Years' Progress in Management," by L. P. Alford, Editor of *Management Engineering,* followed by discussion.

Metropolitan, Oct. 17. In the Engineering Societies Building. A joint meeting with the Taylor Society and the Society of Industrial Engineers. L. P. Alford will read his paper on "Ten Years' Progress in Management."

Mid-Continent, Oct. 28.

Oregon, Oct. 21. The meeting will follow a banquet at 6 p.m. at the University Club, Portland, Ore. The speakers will be P. A. Wickes, chief engineer of the Willamette Iron and Steel Works and C. E. Newlands, manager of the Oregon Portland Cement Co.

Plainfield, Oct. 18. At the Y.M.C.A., Elizabeth, N. J. L. P. Alford's paper, "Ten Years' Progress in Management," will be read and discussed.

Providence, Oct. 31.

St. Louis, Oct. 20. A meeting of the Associated Engineering Societies. The principal speaker will be John Lyle Harrington, of Kansas City, Mo.

Syracuse, Oct. 20.

Toledo, Oct. 13. A joint dinner meeting with the Rotary Club at 12 noon. C. B. Wilson, of the Willys Overland Co., will speak on "Factory Management."

Tri-Cities, Oct. 19. At the Chamber of Commerce, Davenport, Iowa, at 7 p.m. Mr. Alford's paper, "Ten Years' Progress in Management," will be read and discussed.

Western Washington, Oct. 20. At the Engineers Club, Seattle, Wash., at 8 p.m.

Worcester, Oct. 18. A dinner meeting.

In addition, the following sections will hold meetings whose dates have not yet been announced: **Baltimore, New Britain Branch, Waterbury Branch, Minneapolis** and **San Francisco.**

Coming Conventions

Society of Industrial Engineers, 29 West 39th St., New York City. National convention, New York City, Oct. 18-20.

National Association of Practical Refrigerating Engineers; Edward H. Fox, secretary, 5707 West Lake St., Chicago, Ill. Annual convention and exhibition at St. Louis, Mo., Nov. 1-4.

Society of Naval Architects and Marine Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 8-9.

American Society of Mechanical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 4-8.

American Society of Refrigerating Engineers; W. H. Ross, secretary, 154 Nassau St., New York City. Annual meeting at New York City, Dec. 4-6.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 7-13.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Sept. 25, 1922	Oct. 2, 1922
Pool 1,	New York	$5.50–6.00	$5.25–5.75
Smokeless,	Columbus	5.75–6.25	5.00–6.50
Clearfield,	Boston	4.00–5.00	4.25–4.75
Somerset,	Boston	4.25–5.25	4.25–5.00
Kanawha,	Columbus	5.50–6.00	5.75–6.00
Hocking,	Columbus	4.50–5.00	4.50–5.25
Pittsburgh No. 8	Cleveland	4.50–4.75	4.50–5.25
Franklin, Ill.,	Chicago	4.50–5.00	4.50–5.00
Central, Ill.,	Chicago	4.35–4.75	4.35–4.75
Ind. 4th Vein,	Chicago	4.65–5.00	4.65–5.00
West Ky.,	Louisville	4.00–4.50	3.75–4.00
Big Seam,	Birmingham	2.60–3.00	2.60–2.90
S. E. Ky.,	Louisville	5.00–6.25	5.00–5.75

FUEL OIL

New York—Oct. 5, Port Arthur light oil, 22@25 deg. Baumé, 5c. per gal.; 30@35 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

Chicago—Sept. 29, for 24@26 deg. Baumé, $1.20 per bbl.; 32@36 deg., 3½c. per gal. in tank cars, f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—Sept. 12, f.o.b. refinery, Pennsylvania, 36@40 deg. 6¼c.; Kentucky fuel oil, 26@30 deg., 4½c. per gal.; Gas oil, 32@34 deg., 2¾c. per gal.; 36@38 deg., 3c.; 38@40 deg., 3¼c.; Western, 24@30 deg., $1.30 per bbl.

Philadelphia—Oct. 2, 26@28 deg. Baumé, Oklahoma, $1.10@$1.15 per bbl.; 30@34 deg., Oklahoma (group 3). 3@3¼c. per gal.; 16@20 deg. Seaboard, $1.40@$1.50 per bbl.

St. Louis—Sept. 26, f.o.b. Wood River, Ill., refinery, 32@34 deg., Oklahoma (group 3), 3c. per gal.; 36@38 deg., 3¼c. per gal.

New Plant Construction

PROPOSED WORK

Ala., Birmingham—The Alabama Power Co., B. M. Bldg., through its subsidiary, the Alabama Interstate Power Co., has filed application with the Alabama Public Service Comn. and the Chief of Engineers, U. S. War Dept., for permission to develop water power sites along the Tallapoosa River, work to include 3 dams, estimated total horsepower about 120,000.

Ark., Mountain House—W. Wolf is in the market for equipment for light and power plant, also machinery and equipment for proposed cold storage and refrigeration plant.

Calif., Modesto—The Modesto Irrigation Dist. plans to construct 37 mi. of 66 KV wood pole, pin type insulators, copper strand conductor transmission line, involving 740 wood poles, 111 mi. copper and 40 mi. iron wire, 2,400 pin type insulators, etc. Estimated cost $3,500 per mi. P. Jones, Ch. Engr.

Calif., Oakland—The city is having preliminary plans prepared for the construction of a junior high school on Park Blvd. and Hopkins St. Estimated cost $1,000,000. Only $100,000 is available at this time, which will finance the first unit of the proposed structure. C. W. Dickey, City Hall, City School, Archt.

Calif., San Anselmo—Marin County Sanitary Dist. 1, Bd. Directors, received bids for a sewage disposal plant, including sewage treatment tanks, pump house, chlorinator house, sludge beds and outfall sewer line, from Rocca & Calletti, 609 C St., San Rafael, $34,980, G. H. Chick, Napa, $42,450, and H. C. Vensano, 58 Sutter St., San Francisco, $51,200. Noted Sept. 5.

Ill., Astoria—The city council is receiving bids for complete sanitary system, including 1 centrifugal pump, sewage disposal plant and 60,000 gal. settling tank. Estimated cost $40,000. W. A. Fuller Co., 1917 Railway Exchange Bldg., St. Louis, Engrs.

Ind., Clinton—The Wabash Electric Co., plans extensions and improvements to its lines and plant. Estimated cost $50,000.

Ind., Evansville—Bd. Educ. will receive bids until Oct. 26 for the construction of a 2 story, 175 x 290 ft. high school on Harlan Ave. Estimated cost $500,000. J. C. Llewellyn Co., 38 South Dearborn St., Chicago, Ill., Archts. Noted Aug. 22.

Ind., Greenville—The township, V. R. Davis, trustee, will receive bids until Oct. 14 for one 4 cylinder type engine, about 1,000 revolutions per min. and not less than 8 hp.; thermo syphon, cooling type with radiator with forced oil feed and splash lubrication; a generator to be compound wound, 6 kw., 110 volt d.c. to be direct connected and on same base through a flexible coupling; batteries to be of glass jar type, 56 cells, 110 volt with capacity of 120 ampere hours on a continuous 8 hour basis rating; switchboard to be mounted on plant, automatic circuit breaker, ammeter and volt meter properly fused and pulley on generator shaft to drive the pump by engine power, belted to pumping unit, which is to be installed.

Ind., Indianapolis — Marion County Comrs., is in the market for a vacuum pump, 26,000 sq.ft. radiation, with motor attached, for the court house, here.

Ind., Laporte—The School Bd. plans to build a 2 story, 160 x 175 ft. high school. Estimated cost $300,000. Miller, Bullenvider & Dowling, North Michigan Ave., Chicago, Engrs.

Ind., Logansport—The Universal Burner Co. is in the market for several steam pumps, air compressors, also electric motors suitable for driving and operating steam pumps, oil pumps, air compressors, etc., to be used in the manufacturing of liquid fuel burning equipment.

Ind., Pendleton—The Indiana State Reformatory, J. H. O'Neall, Purch. Agt., is receiving bids for power plant equipment, consisting of 4 horizontal type water tube boilers, 400 hp. each; 5 steam driven outside packed duplex boiler feed pumps; 1 steam driven and one electric driven vacuum pumps, 1 hot water heater and a 12,000 gal. per hour capacity storage tank; a water softener; 3 engine generators; hot and cold water circulating pumps, steam driven; 2 open type feed water heaters; air compressor and fire line pumps.

Ind., South Bend—R. Elbel plans to build a 4 story, 165 x 235 ft. apartment building on North Michigan St. Estimated cost $350,000. Architect not selected.

Ind., Upland—The Upland Water Co., plans the construction of a waterworks plant. Estimated cost $45,000. Engineer not announced. Prices wanted on electrical pumping machinery and other equipment.

Ia., Des Moines—E. W. Nothstine is having plans prepared for a 6 story, 127 x 264 ft. garage, on 5th and Chestnut Sts. Estimated cost $300,000. Proudfoot, Bird & Rawson, 810 Hubbell Bldg., Archts.

Kan., Kansas City—The city, H. Payne, Clk., will soon receive bids for the construction of a 3 story, 75 x 120 ft. memorial building. Estimated cost $500,000. Rose & Peterson, 434 Brotherhood Bldg., Archts.

Ky., Newport—The city Comrs., Mayor Herman, Chn., will receive bids until Nov. 14 for furnishing pumping equipment in connection with new waterworks plant. Estimated cost $150,000. Engineer not announced.

Mass., Easthampton—The town is having sketches prepared for a 2 story, 104 x 256 ft. high school, including gymnasium, etc. Estimated cost $250,000. P. B. Johnson & R. B. Warner, 348 Main St., Springfield, Archts.

Mich., Detroit—G. Klein, c/o A. Kahn, Archt., 1000 Marquette Bldg., is receiving bids for the construction of a 10 story, 107 x 120 ft. apartment building, including steam heating plant, boilers and equipment, on Pingree Ave.

Mich., Detroit — The Public Lighting Comn., is having plans prepared for power plant in the southwestern part of city, to have an ultimate capacity of 150,000 kva. of which 4 units of 25,000 kva. each will be installed at the present time, to provide for all municipal requirements, such as lighting public buildings and streets, waterworks and sewage pumping stations and street railway system; also a complete transmission system will be installed, including substations for street railway. Bids will soon be taken on boilers, stokers, economizers, turbines and condensers. Smith, Hinchman & Grylls, 800 Marquette Bldg., Archts. and Engrs.

Mich., Loretto—The Peninsular Power Co., Madison, is having plans prepared for a hydroelectric power plant, a 55 ft. arch dam 250 ft. long, single vertical unit, 1000 kw., 60 cycle, 3 phase, also a transmission line from new plant to adjoining places. Estimated cost $200,000 and $25,000 respectively. Mead & Seaston, Journal Bldg., Madison, Engrs.

Minn., Bemidji—The Minnesota Associated Lumber Co., plans to build a large lumber mill. Estimate cost $500,000. Architect not announced.

Minn., Chisholm—The Bd. Educ., E. E. Brew, Clk., will receive bids about Dec. 1 for a 3 story junior high school, including steam heating system and equipment for industrial departments. Estimated cost $750,000. German & Jensen, Exchange Bank Bldg., Duluth, Archts.

Minn., Duluth—The St. Louis Co. Bd., F. W. Borgen, Co. Auditor, Court House, will receive bids about Oct. 19, to be opened Nov. 1, for the construction of a 4 story, 49 x 132 ft. county jail, including steam heating system, on Second St. and 6th Ave., E. Estimated cost $400,000. Halstead & Sullivan, 407 Palladio Bldg., Engrs. and Archts. Noted Mar. 29.

Mo., Bunceton—The city has asked engineers to prepare preliminary data for the construction of a pumping plant and distribution system. Estimated cost $35,000.

Mo., Columbia—The Missouri University, E. E. Brown, Bus. Mgr., 117 Jesse Bldg., will receive bids until Oct. 16 for a 3 story hospital, including heating and ventilating systems, ice and refrigerating plant. Estimated cost $175,000 to $200,000. Jamieson & Spearl, Arcade Bldg., St. Louis, Archts.

Mo., Jefferson City—C. J. Huegel will soon receive bids for the construction of a hotel building. Estimated cost $500,000. Hellmuth & Hellmuth, De Menil Bldg., St. Louis, Archts.

Mo., Pilot Grove—The city plans an election to vote $40,000 bond issue for complete water distribution system, including pumps, etc. Engineer not selected.

Mo., St. Charles—The city plans an election to vote a $66,000 bond issue for water works system, including pumps and other water works machinery, $25,000, meters, meter connections, flow meters, cast iron water and cleaning mains, $41,000. P. W. Loonam, City Engr.

Mo., St. Louis—The city is receiving bids for a hot water system, including generators and small pumps, also a garbage reduction plant, for the Robert Koch Hospital. Estimated cost $25,000. W. E. Bowen, 305 City Hall, Engr.

Mo., St. Louis—The city will soon receive bids for a 1 and 2 story 50 x 225 ft. service plant, including two 220 hp. oil burning water tube boilers, 2½ ton ice plant and 10 ton refrigerating plant, for the training school at Scott Farm. Estimated cost $150,000. W. E. Bowen, 305 City Hall, Archt. and Engr.

Mo., St. Louis—The City Club, Bd. Educ. Bldg., will soon receive bids for a 12 story, 60 x 122 ft. hotel, including complete heating and ventilating systems, on 11th and Locust Sts. Estimated cost $700,000. T. P. Barnett Co., 1549 Arcade Bldg., Archts. and Engrs.

N. H., Sunapee—The Lake Sunapee Power Co., I. M. Frost, Pres., Rutland, Vt., will soon receive bids for hydro-electric station, dam, and about 1,500 ft. penstock, to develop 1,500 hp., at Lake Sunapee. Estimated cost $300,000.

N. J., Camden—Bd. Educ., City Hall, is having plans prepared for the construction of a 2 story high school on Park Blvd. and Euclid Ave. Estimated cost $450,000. C. Adams, 2036 Spruce St., Phila., Archt.

N. Y., Brooklyn—The Knights of Columbus, 244 West 51st St., New York City, plan to build a club building, here, on Prospect Pk. West and Union St. Estimated cost $2,000,000. Architect not selected.

N. Y., Brooklyn—The Rubel Coal & Ice Corp., Glenmore Ave., is in the market for ice making machinery for proposed ice plant, on Atlantic Ave. Noted Oct. 3.

N. Y., Buffalo—The Buffalo Cold Drawn Steel Co., F. R. Kew, Dir. and Prod. Mgr., has purchased a 3½ acre site and plans the construction of a plant, annual capacity, 36,000 ton.

N. Y., Jamestown — The Jamestown Lounge Co., 40 Winsor St., plans to build a 6 story, 102 x 104 ft. addition to its factory. Architect not announced. Is in the market for machinery and equipment.

N. Y., Niagara Falls—J. S. Thompson and P. A. Porter, Marine Bank Bldg., plan to build a 1,000,000 hp. hydro-electric project at Foster Flats, lower Niagara. Estimated cost $40,000,000.

N. Y., New York—The Fain Knitting Mills, 902 Park Ave., Bklyn., plans to build a 12 story office building on 34th St. and Bway., here. Architect not selected.

N. Y., New York—N. J. Hayes, Comr. Water Supply, Gas & Electricity, Rm. 2351, Municipal Bldg., will receive bids until Oct. 10 for furnishing, delivering, installing and connecting a multi-stage centrifugal pump and motor at auxiliary pumping station 1, Southfield Blvd., Boro. of Richmond.

N. Y., New York—The Jatisen Constr. Co. c/o Schwartz & Gross, Archts. and Engrs., 347 5th Ave., is having plans prepared for a 14 story, 100 x 122 ft. apartment building, including steam heating system, at 1050 Park Ave. Estimated cost $1,500,000.

N. Y., New York—The Dept. of Public Welfare, B. S. Coler, Comr., Municipal Bldg., is having plans prepared for a hospital, including steam heating system, on Walton Ave. and 167th St. Estimated cost $2,500,000. C. B. Meyers, 31 Union Sq., Archt. and Engr.

N. Y., Sheepshead Bay — The Superior Ice Co., Inc., 50 East 42nd St., is in the market for ice making machinery for proposed ice plant on Avenue Z and East 17th St., here. Noted Oct. 3.

Ohio, Bellaire—The city will vote, Nov. 7, on a $350,000 bond issue for the construction of a new high school on 35th and Guernsey Sts.

Ohio, Blanchester—The Fulflo Specialties Co. is in the market for 1 belt driven, modern air compressor, 100 to 350 ft. at 100 lbs. pressure.

Ohio, Columbus—Constructing Quartermaster, U. S. Army, plans to replace boilers in building 57 at the barracks, here.

Ohio, Cincinnati—The J. A. Fay & Egan Co., John & Front Sts., are having revised plans prepared for machine shop, floor space about 80,000 sq.ft., on Paddock Rd. and Tennessee Ave. Estimated cost $400,000. C. M. Stegner, 1700 Union Trust Bldg., Archts. and Engrs. Former bids rejected.

Ohio, Cleveland—The Brotherhood of Locomotive Engineers, c/o W. S. Stone, Pres., Engineers Bldg., plans to build a 21 story 94 x 144 ft. bank and office building, including steam heating system, on West 3rd St. and St. Clair Ave. Estimated cost $5,000,000. Knox & Elliot, Engrs. Bldg., Archts.

Ohio Cleveland Heights (Warrensville P. O.)—M. Arnoff, 10025 North Blvd., Cleveland, plans to build a 4 story apartment building on Cedar Rd., here. Estimated cost $450,000. Private plans.

Ohio, Cleveland Heights (Warrensville P. O.)—M. Makoff, 2740 East Blvd., Cleveland, is having plans prepared for a 3 story, 44 x 185 ft. apartment building, here, including steam heating system. Estimated cost $250,000. A. F. Janowitz, Permanent Bldg., Cleveland, Archt.

Pa., Altoona—Bell Telephone Co. of 13th and Arch Sts., Philadelphia, plans to build a 6 story, 110 x 140 ft. business block on 12th Ave. and 16th St., here. Estimated cost $1,000,000. Architect not selected.

Pa., Altoona—The Pennsylvania R.R. Co., Broad St. Station, Phila., plans to build a power house and electrify a 4 track system from here to Johnstown. Estimated cost $10,000,000. A. C. Shand, Ch. Engr.

Pa., Beaver—Beaver College, J. W. Thoburn, Pres., plans to build a group of college buildings on a 45 acre site, here. Estimated cost $1,000,000.

Pa., Bellefonte—G. Kelley plans to build a modern ice making plant, here. Estimated cost $18,000.

Pa., Brackenridge—The Atlantic Bottle Co. plans to rebuild factory recently destroyed by fire. Estimated cost $300,000. Architect not announced.

Pa., Coraopolis—The Vulcan Refining Co. is having plans prepared for a 56 x 60 ft. boiler house. E. C. Dilworth, 302 Walsh Bldg., Pittsburgh, Engr.

Pa., Kinzua—The Kinzua Light & Power Co., E. W. Chichester, Dir., is in the market for electrical machinery, turbines and equipment for power plant to supply electric light and power to the village and vicinity.

Pa., Oakmont — H. L. Reinhold, Jr., Archt., 1513 Walnut St., Phila., is receiving bids for a 3 story, 180 x 181 ft. store and apartment building, here, including steam heating system, for Dearshall, Inc. Estimated cost $350,000.

Pa., Phila.—Ballinger & Co., Archts., 12th and Chestnut Sts., are receiving bids for a 9 story, 34 x 74 ft. store and loft building at 112 North 12th St., for W. E. Herring. Estimated cost $750,000. Noted Sept. 12.

Pa., Phila.—I. Stern, Lincoln Bldg., will soon receive bids for an 8 story office building on 15th and Spruce Sts. Estimated cost $500,000. L. B. Rothchild, 1225 Samson St., Archt.

Pa., Pittsburgh—Jones & Laughlin Steel Co., 3rd and Ross Sts., is in the market for a 50 ton crane with 10 ton auxiliary for power house.

Tenn., Kingsport—The Mead Fibre Co., plans to build a machine paper mill plant. Estimated cost $750,000. Management Engr. and Developement Co., c/o owner, Engrs. Prices wanted on machinery and equipment.

Tenn., Knoxville—The Appalachian Marble Co., Middlebrook Pk., is in the market for pumping outfit, preferably a direct connected turbine set, 50 gal. per min. capacity against head of 85 to 100 lb. guage pressure.

Tenn., Knoxville—The Knoxville Power & Light Co. has increased its capital stock from $2,000,000 to $10,000,000, the proceeds to be used for the construction of additions and improvements to its lines and plants.

Tenn., Parksville, (Benton P. O.)—The Tennessee Power Co., plans to issue $250,000 bonds for extensions and improvements to lines and plants. Engineer not announced.

Tex., Dallas—The Texas Interurban Ry. plans to electrify the tracks of the Missouri, Kansas & Texas R.R., between here and Denton, a distance of 30 mi.

Va., Norfolk—Constructing Quartermaster, U. S. Army, plans the construction of 2 power houses with wells, fuel tank, etc., for 16 in. emplacements at Fort Story.

Va., Richmond—The Imperial Tobacco Co., 106 South 6th St., is in the market for oil burning equipment, to replace coal burning equipment, in its power house.

Va., Richmond—The Richmond, Fredericksburg & Potomac R.R. Co., R. J. Rouse, Purch. Agt., will be ready to place orders in about 60 days for washout system for cooling plant, including pump and tanks, also complete outfit for blacksmith shop, including air compressors, engine, boiler, etc.

Wis., Fort Atkinson—The city, W. D. Leonard, Clk., will receive bids until Oct. 11 for pumping station, including one 300 gal. motor driven centrifugal pump, one 1,000 gal. motor and engine driven pump, 1 remote control starter for 1,000 g.p.m. pump, 1 belt driven air compressor with accessories, also furnishing and laying 5,200 ft. 6 in. water pipe, etc.

Wis., Lakemills—The city, N. H. Falk, Clk., plans to purchase new boiler and equipment for power plant. Private plans.

Wis., Luona—The Connor Lumber Co., is having plans prepared for a dam to replace present one, also gate hoist. Estimated cost $25,000. La. A. DeGuere, Wisconsin Rapids, Engr.

Wis., Madison—Mead & Seaston, Engrs., Journal Bldg., are receiving bids for a 5,000 kw. turbine with auxiliaries, 225 lb. pressure, 100 degrees superheat, also piping for boilers, for the Madison Gas & Electric Co., 120 East Main St.

Wis., Milwaukee—The Bd. of Industrial Educ., 7th and Prairie Sts., is having plans prepared for a 6 story, 147 x 240 ft., continuation school, (3rd unit) on 6th St. Estimated cost between $800,000 and $1,000,000. Van Ryn & De Gelleke, 114 Grand Ave., Archts. Noted Nov. 15, 1921.

Wis., Milwaukee—The Comn. of Agriculture, C. P. Noyard, Chn., Capitol Bldg., plans to build a 100 x 300 ft. exhibit building at the State Fair grounds. Estimated cost $500,000. Architect not selected.

Wis., Milwaukee — Sixth & Grand Bldg., Corp., c/o Rapp & Rapp, Archts., 190 North State St., Chicago, is having plans prepared and will soon receive bids for the construction of a 6 story, 180 x 225 ft. office and theatre building, including steam heating system, on Sixth and Grand Sts. Estimated cost $500,000.

Wis., Oconto—The Bd. Educ. plans to install a steam heating plant and boilers in main school building. Engineer not selected.

Wis., Superior—The Bd. Educ., L. A. Nichols, Secy., will receive bids until Oct. 17 for a 2 story, 105 x 256 ft. high school, including steam heating system, on West 5th St. Estimated cost $250,000. F. E. Johnson, 25 Wisconsin Blk., Archt. and Engr.

Wis., Union Grove—The State Bd. of Control, M. J. Tappins, Secy., Madison, will receive bids until Oct. 10 for an electrical distribution system, switchboard and connections for the State Home for Feeble Minded, here. A. Peabody, Capitol Bldg., Engr.

Wis., Watertown—St. Paul's Episcopal Congregation, 409 2nd St., is having plans prepared for a steam heating plant, including boiler, for church and auditorium. Claude & Starck, Badger Annex, Madison, Engrs.

Ont., Alvinston—The town, J. Irving, Clk., passed a by-law authorizing purchase and installation of a 500 or 1,000 g.p.m. electric driven, 3 stage electric fire pump and new pump house.

Ont., Cannington — The town is having plans prepared for a waterworks system, including turbine pumps, electric motors, standpipe and c.i. mains. Estimated cost $50,000. James, Proctor & Redfern, Ltd., Engrs.

Que., Montreal—The Red Star Refineries, Ltd., Canada Cement Bldg., is in the market for general power plant and electric light and power equipment, pumps, compressors, general insulating materials, storage tanks, agitators, stills, preheaters, exchangers for vapor and liquid, coolers, towers, condensers, etc., for plant at Montreal East.

Ont., Timmins — The Peninsular Mines plan to build a 200 ton mill (gold mining) and power house, at Night Hawk Lake. Prices wanted on power house equipment.

CONTRACTS AWARDED

Ill., Chicago — Edelson & Paulin, c/o Loewenberg & Loewenberg, Archts., 111 West Monroe St., awarded the contract for the construction of an 8 story, 150 x 150 ft. apartment house at 2428-28 Pine Grove Ave., to O. W. Rosenthal-Cornell Co., 80 East Jackson Blvd. Estimated cost $1,000,000. Steam heating system will be installed.

La., New Orleans—The Algiers Dry Dock & Ship Repair Co., Ltd., E. Berthaut, Pres., 334 Powder St., will build a floating dock, 10,000 deadweight ton capacity. Estimated cost $400,000.

Md., Williamsport—The Potomac Service Co., Hagerstown, will build a 30,000 kw. a.c. steam generating plant here. Estimated cost $2,000,000.

Mass., Boston—The Realty Investment Trust, c/o Coolidge & Shattuck, Archts., 122 Ames Bldg., awarded the contract for a 12 story, 105x110 ft. office building on Beacon and Somerset Sts., to the G. A. Fuller Co., 131 State St. Estimated cost $1,250,000. Steam heating and modern ventilating systems will be installed.

Mass., Waverly—The State Dept. of Mental Diseases, W. A. Merrill, Bus. Agt., State House, Boston, awarded the contract for a 75 x 78 ft. power house, for the Massachusetts School for Feeble Minded, here, to J. J. Trindiville, South Framingham, $36,041. Noted Sept. 26.

Mich., Detroit — Detroit Life Insurance Co., 4709 Woodward Ave., awarded the contract for the construction of a 10 story, 40 x 96 ft. office building, including steam heating plant, boilers and accessories, on Park Blvd. to O. Misch Co., 1370 Bway. Ave.

N. Y., Brooklyn—The New York Telephone Co, 15 Dey St., New York, has awarded the contract for an 8 story addition to telephone exchange on Willoughby Ave., here, to James Stewart & Co., 30 Church St., New York. About $1,000,000. Noted Mar. 7.

N. Y., Geneva—The Lisk Mfg. Co., Canandaigua, awarded the contract for the construction of a 160 x 280 ft. enamel ware plant, here, to Curan-Mason Inc., Rochester. Estimated cost $1,000,000. Noted Sept. 26.

N. Y., New Rochelle—The Pintard Apartments, Inc., c/o E. D. Litchfield, Archt., 477 5th Ave., New York City, awarded the contract for the construction of a 6 story, 100 x 152 ft. apartment building, on Main St. and Pintard Ave., here, to T. J. Steen, 8 East 41st St., New York City. Estimated cost $500,000. Steam heating system will be installed.

N. Y., New York—The Joint Ownership Constr. Co., F. Culver, Pres., c/o Rouse & Goldstone, Archts., 512 5th Ave., awarded the contract for 2 apartment buildings on 69th St. and Lexington Ave., to Hegeman-Harris, 184 Madison Ave. Estimated cost $750,000. Steam heating system will be installed.

N. Y., New York—The 9-11 East 41st St. Corp., C. A. Conlon, Pres., c/o Townsend, Steinle & Haskell, Engrs. and Archts., 8 West 40th St., awarded the contract for the construction of a 12 story, 93 x 144 ft. office building. Estimated cost $300,000. Steam heating system will be installed.

Ohio, Cleveland—The Bd. Educ., F. G. Hogan, Dir., East 6th St. and Rockwell Ave., awarded the contract for the construction of a 3 story, 300 x 311 ft. high school, on East 152nd St. and St. Clair Ave., to The Drummond-Miller Co., 4500 Euclid Ave. Estimated cost $1,681,865. Steam heating system will be installed. Noted Oct. 3.

Ohio, Marion—The city awarded contracts for the construction of a sewage disposal plant to A. Bentley & Son Co., 201 Belmont Ave., Toledo, $435,000; sewer system, to Kohlbarger & Hoyles, $76,316. Noted Aug. 29.

Pa., Carbondale—The Bd. Educ. awarded the contract for heating and ventilating systems in new school, to W. C. Williams, 36 North Main St., Wilkes-Barre, $28,162.

Pa., Jeannette—The American Window Glass Co., Farmers' Bank Bldg., Pittsburgh, awarded the contract for addition to plant, here, including power house, boiler house, etc., to Heyl & Patterson, Inc., 51 Water St., Pittsburgh. Estimated cost $1,500,000. Noted Sept. 19.

Tex., San Antonio—H. H. Rogers, Central Trust Bldg., and associates awarded the contract for a 9 story, 100 x 100 ft. hotel on Travis and Main Sts., to J. DePuy, Bedel Bldg., about $300,000.

Wis., Dane—The Wisconsin Light & Power Co., 900 Gay Bldg., Madison, will build, by day labor, a 66,000 volt transmission line to carry energy for Prairie du Sac plant to eastern Wisconsin distribution system. Private plans.

Wis., Elroy—The Bd. Educ., O. F. Miller, Clk., awarded the contract for the construction of a central heating plant, including equipment and boilers, for city schools, to the Steffen Mfg. Co., Main St. Estimated cost $25,000.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Advances—Lower discounts on rawhide lacing and asbestos pipe and boiler covering. Portland cement $2.60@$2.75 as against $2.60 per bbl., without bags, and steel structurals, $3.14 as compared with $3.04 per 100 lb., delivered, New York City. Red and white lead up ¼c. per lb., base. Lower discounts on steel rivets in New York and Cleveland warehouses; structural and boiler rivets higher at mill. All refractories higher except silica brick. Cold finished steel up 25c. in New York and 15c. per 100 lb. in Cleveland. Discounts reduced on boiler fitting-up bolts. Discounts 5½ points lower on wrought-iron pipe, since Pittsburgh basing card of Aug. 23. Boiler tubes higher in New York warehouses. Five per cent advance in prices of conduit, elbows and couplings. Fuse plugs up 10c. per package.

Declines—Steam hose discounts higher. Wiping cloths cheaper in Cleveland. Linseed oil, raw, down 13c. in Cleveland and 2c. per gal., f.o.b. Chicago, during month. Pear-shaped or bowl enameled, Mazda "C" lamps, clear or frosted, down 10c. per package and rubber-covered solid copper wire, single braid, No. 14, down 26c. per M. ft., f.o.b. New York.

POWER-PLANT SUPPLIES

HOSE—

	Fire	50-Ft. Lengths
Underwriters' 2½-in., coupled		49½c. per ft.
Common, 2½-in., 3-ply	1.00 per ft. list less 50%	

	Air	
	First Grade	Second Grade
¾-in., 3-ply, per ft.	$0.31	$0.22½

Steam—Discounts from List		
First grade....50–5%	Second grade....50–10%	Third grade....60%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition	65–10%	Best grade	60–5%

LEATHER BELTING—List price per ply, 12-in. wide, per lin. ft. $2.88

Grade	Discount from list
Medium	40–5%
Heavy	30–5%

RAWHIDE LACING { For cut, best grade, 40%; 2nd grade, 50%. For laces in sides, best, 48c. per sq.ft.; 2nd, 43c. Semi-tanned: cut, 40%; sides, 48c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ½ in.	$0.90
Asbestos for high-pressure steam, ½ in.	1.80
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.90
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.70

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50% off
For low-pressure heating and return lines	4-ply	70% off
	3-ply	72% off
	2-ply	74% off

PORTLAND CEMENT—New York, $2.60@2.75 per bbl. without bags, in cargo lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.14 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York Current	Cleveland	Chicago
White	9.00@11.50	12.00	11.25
Mixed	6.50@10.00	9.00	8.00

WIPING CLOTHS—Jobbers' prices, in cents per lb., as follows:

	13¼ x 13¼	13¼ x 20½
Cleveland	6.00	9.60
Chicago	10.00	13.00
New York	7.50	8.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.91	$1.01	$0.97

WHITE AND RED LEAD—Base price per pound:

	Red				White			
	Current		1 Year Ago		Current		1 Yr. Ago	
	Dry	In Oil	Dry	In Oil	Dry or In Oil	Dry or In Oil	Dry or In Oil	Dry or In Oil
100-lb. keg	12.75	14.25	12.25	13.75	12.75	12.25	12.25	11.75
25- and 50-lb. keg	13.00	14.50	12.50	14.00	13.00	12.50	12.50	12.00
12½-lb. keg	13.25	14.75	12.75	14.25	13.25	12.75	12.75	12.25
5-lb. cans	15.75	17.25	15.25	16.75	15.75	15.25	15.25	14.75
1-lb. cans	17.75	19.25	17.25	18.75	17.75	17.25	17.25	16.75

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	45%	60%	60%
Tinned	50%	60%	4½c. per lb. net

Structural rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.
New York....$3.85 Chicago....$3.35 Pittsburgh....$3.00

Boiler rivets, same sizes:
New York....$3.95 Chicago....$3.45 Pittsburgh....$3.10

REFRACTORIES—Prices in carlots:

Chrome brick, eastern shipping points	net ton	$50@53
Chrome cement, 40@50% Cr_2O_3	net ton	25@28
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	29@32
Magnesite brick: 9-in. shapes	net ton	75@77
Magnesite brick: 9-in. arches, wedges and keys	net ton	82.50@84.50
Magnesite brick: Soaps and spits	per ton	105@107
Silica brick: Chicago district	per 1,000	50@53
Silica brick: Birmingham, Ala.	per 1,000	52@55
Silica brick: Mt. Union, Pa.	per 1,000	45@47
Chrome ore crude, 45@50%	net ton	20@22
Magnesite dead burn	net ton	45@47
Clay brick, 1st qulity, 9-in. shapes, Missouri	per 1000	40@45
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per 1000	36@39
Clay brick, 1st quality, 9 in. shapes, Ohio	per 1000	36@39
Clay brick, 1st quality, 9 in. shapes, Kentucky	per 1000	36@39
Clay brick, 2nd quality, 9-in. shapes, Missouri	per 1000	30@35
Clay brick, 2nd quality, 9 in. shapes, Pennsylvana	per 1,000	32@36
Clay brick, 2nd quality, 9 in. shapes, Ohio	per 1,000	32@36
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per 1,000	32@36

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
Fair grade	25.00	42.25	36.00
Commercial	15.00	16.00	9.00

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting and screw stock, per 100 lb. base	$3.90	$3.70	$3.60
Flats, square and hexagons, per 100 lb. base	4.40	4.20	4.10

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	55%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	68	56½	¼ to 1¼	34	19

LAP WELD

2	61	49½	2	29	15
2½ to 6	65	53½	2½ to 4	32½	19
7 to 8	62	49½	4½ to 6	32½	19
9 and 12	61	48½	7 to 12	30	17

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	66	55½	¼ to 1½	34	20
2 to 3	67	56½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	59	48½	2	30	17
2½ to 4	63	52½	2½ to 4	33	21
4½ to 6	62	51½	4½ to 6	32	20
7 to 8	58	45½	7 to 8	25	13
9 to 12	52	39½	9 to 12	20	8

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$0.23
1¼	.....	.....	.25
1½	.....	.....	.22
1¾	$0.26	$0.29	.23
2	.20	.25	.21
2¼	.23	.29	.23
2½	.24	.33	.28
2¾	.....	.....	.....
3	.30	.41	.32
3½	.32	.47	.35
3½	.34	.51	.37
4	.43	.64	.47

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.
These prices are net per lineal foot based on stock lengths. If cut to special engths, billing will be based on the entire stock lengths.
In addition to the above, standard cutting charges are as follows:
1¼ in. to 2 in. diameter, 5c. per cut. 2½ in. diameter, 7c. per cut
2½ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3½ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$ 42.00 (net)	$59.00(net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

Less than coil lots	40%	20%
Coils to 1,000 ft.	45%	30%
1,000 to 5,000 ft.	50%	35%
5,000 ft. and over	50–10%	40%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f. o. b. New York, with 10-day discount of 5 per cent.

Size, In.	Conduit Per M	Conduit Per M	Elbows Per C	Elbows Per C	Couplings Per C	Couplings Per C
¾	$52.12	$57.47	$9.26	$10.45	$5.10	$5.54
¾	66.89	74.14	12.18	13.75	7.28	7.91
1	95.31	106.02	18.02	20.75	9.47	10.29
1¼	128.96	143.45	24.28	27.12	13.28	14.35
1½	154.19	171.51	32.38	36.16	16.40	17.72
2	207.45	230.76	59.36	66.29	21.87	23.63
2½	328.00	364.86	97.14	108.48	31.25	33.76
3	428.93	477.13	259.05	289.29	46.87	50.65
3½	544.82	602.78	572.08	722.86	62.49	67.53
4	668.38	737.05	661.13	738.30	78.12	84.42

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.08	D. P. D. B.	$0.26
D. P. M. L.	.13	T. P. S. B.	.25
T. P. M. L.	.19	T. P. D. B.	.38
D. P. S. B.	.15		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.38	$1.20	$1.25
T. P. M. L.	.53	1.40	1 80
D. P. S. B.	.47	1.20	....
T. P. S. B.	.88	2.00	.....
D. P. D. B.	.85	2.35	.....
T. P. D. B.	1.50	4.00	.....
T. P. to D. P. D. B.	1.00	2.75	.. ..

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$19.95
No. 16 cotton reinforced heavy	26.15
No. 18 cotton reinforced light	17.33
No. 16 cotton reinforced light	21.50
No. 18 cotton Canvasite cord	14.70
No. 16 cotton Canvasite cord	17.06

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$.20	3-amp. to 30-amp.,	100	$0.40
35-amp. to 60-amp.,	100	0 30	35-amp. to 60-amp.,	100	.60
65-amp. to 100-amp.,	50	2.90	65-amp. to 100-amp.,	50	1.50
110-amp. to 200-amp.,	25	3.00	110-amp. to 200-amp.,	25	2.50
225-amp. to 400-amp.,	25	5.60	225-amp. to 400-amp.,	25	5.50
475-amp. to 600-amp.,	10	.50	450-amp. to 600-amp.,	10	8.00

Discount: Less 1-5th standard package, 55%; 1-5th to standard package, 60%; standard package, 65%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package	$2.50
0–30 ampere, less than standard package	2.85

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.35	$0.40	100	75	$0.60	$0.65	50
15	.35	.40	100	100	.75	80	24
25	.35	.40	100	150	1.00	1.10	24
40	.35	.40	100	200	1.30	1.40	24
50	.35	.40	100	300	1.90	2.00	24
60	.40	.45	100				12
				500	2.75	2.90	12
				750	4.00	4.25	8
				1,000	4.50	4.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.17
Composition 2-piece attachment plug	.26
Swivel attachment plug	.12

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$ 6.30	$ 8.00	$10.02	$15.96
12	8.72	10.60	12.54	20.84
10	11.44	13.65	15.96	27.09
8	15.38	17.90	21.05	36.22
6	.....	.....	31.81	.....
4	.....	.....	42.94	.....
2	.....	.....	64.99	.....
1	.....	.....	86.83	.....
0	.....	.....	107.78	.....
00	.....	.....	127.89	.....
000	.....	.....	153.66	.....
0000	.....	.....	183.70	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	½ In. or Pendant Cap Keyless Each	½ In. or Pendant Cap Pull Each	¾ In. Cap Key Each	¾ In. Cap Keyless Each	¾ In. Cap Pull Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	15%
1-5th to standard package	30%
Standard package	45%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	21c. lb
Soldering paste, 2 oz. cans	$1.00 doz

ENCLOSED SWITCHES, KNIFE—Externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:

Less than $25.00 list value	25%
$25 to $50 list value	30%
$50 list value or over	35%